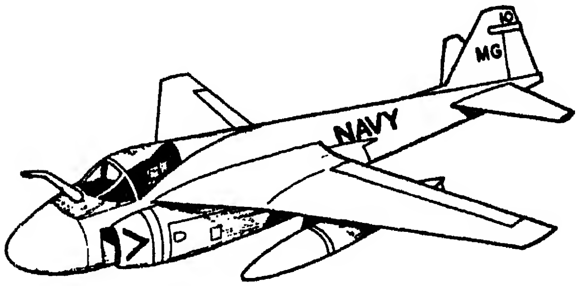
AVIONICS TECHNICIAN COURSE, CLASS A1



MODULE 5-6

RADAR PULSE MODULATOR AND TRANSMITTER CIRCUITS

CNTT-M1243
(REV. 8-84)

Naval Air Technical Training Center
Naval Air Station Memphis,
Millington, Tennessee

AVIONICS TECHNICIAN COURSE, CLASS A1

UNIT 5

MODULE 6

LESSON TOPIC 1

THREE PHASE POWER SUPPLY AND OVERLOAD PROTECTION CIRCUITRY

NOVEMBER 1975

OVERVIEW

LESSON TOPIC 5-6-1

THREE PHASE POWER SUPPLY AND OVERLOAD PROTECTION CIRCUITRY

In airborne equipment, the primary ac and dc voltages are supplied from the aircraft's power system to the various units in the radar system. Within these various power supplies the voltages are stepped up or down, and if necessary, rectified, to fulfill the requirements of the system.

The power supplies used in airborne search radar systems are of many different types - such as bridge, half-wave, full-wave, etc. with many of these circuits utilizing voltage regulators to maintain critical voltage levels. A complete analysis of a typical three-phase power supply and high voltage power supply is given in this lesson. Overload protection circuits will also be covered in detail, as to their relationship and function in conjunction with the three-phase power supply.

The Learning Objectives of this Lesson Topic are as follows:

1. Select from a list the statement that describes the purpose of an ac indicating fuseholder.

2. Select from a list the schematic symbol for an ac indicating fuseholder.

3. Select from a list the statement that describes the purpose of the thermal time delay relays.

4. Select from a list the schematic symbol for a thermal time delay relay.

5. Select from a list the statement that describes the purpose of a dc indicating fuseholder.

6. Select from a list the schematic symbol for a dc indicating fuseholder.

7. Select from a list the statements that describe the purpose/ function of the three-phase full-wave rectifier.

8. Select from a list the components in the three-phase full-wave rectifier.

9. Select from a list the statement that describes the purpose of the overload protection circuit.

OVERVIEW (CONT)

10. Select from a list the components in the overload protection circuit.

11. Select from a list the components in the inverse-current sensing circuit.

12. Select from a list the statements that describe the electrical operation of the inverse-current sensing network.

NOTE: All objectives in this lesson topic must be accomplished with 100 percent accuracy, unless otherwise stated.

Prior to beginning this lesson topic, carefully review the "List of Study Resources". Keep in mind that your learning supervisor can be your most valuable learning resource. Always feel free to consult with him if you have problems or questions.

LIST OF STUDY RESOURCES

LESSON TOPIC 5-6-1

THREE PHASE POWER SUPPLY AND OVERLOAD PROTECTION CIRCUITRY

To learn the material in this lesson topic, you may choose, according to your experience and preferences, any or all of the following study resources.

WRITTEN LESSON TOPIC PRESENTATIONS IN MODULE BOOKLET:

1. Lesson topic summary.
2. Programmed instruction form of lesson topic.
3. Narrative form of lesson topic.
4. Lesson topic progress check.

ADDITIONAL MATERIALS REQUIRED FOR SUCCESSFUL COMPLETION OF LESSON TOPIC:

1. Job program in Job Program Booklet
2. Student response sheets
   a. Job data sheet
   b. Answer sheet for use with test
   c. Programmed instruction response sheets

ENRICHMENT MATERIALS:

Maintenance Instruction Manual, 15A21 Airborne Search Radar System Trainer.

All the resources listed above are available and may be used as you see fit. Your learning supervisor represents a most valuable learning resource. Use him when you need help. It is not necessary to use all the resources to achieve the learning objectives for the lesson topic. The lesson topic progress check is your means of determining when you have achieved the objectives. The progress check may be taken at any time and is graded by you. If you fail to achieve any objective at the lesson topic level, you will plan and accomplish your own remediation. If you need help in remediation, consult your learning supervisor.

PROGRAMMED INSTRUCTION

THREE PHASE POWER SUPPLY AND OVERLOAD PROTECTION CIRCUITRY

1. The modulator power supply of a typical airborne search radar is shown in the schematic for the MODULATOR POWER SUPPLY GROUP. (Refer to figure 2-21 in the MIM) The high voltage power supply is a normal three-phase full wave rectifier power supply used to furnish the voltages necessary for operation of the receiver-transmitter (A6 unit). Primary operating power for the modulator power supply is controlled by the RADAR SET CONTROL OFF-STDBY-ON switch (A7S1). Power is applied through three ac indicating fuseholders designated as XF1, XF2, and XF3. The purpose of the ac indicating fuseholder is to provide a visual indication of a good or bad fuse in the ac line.

The ac indicating fuseholder provides a visual indication of a ______ or ______ fuse in an ac circuit.

good
bad

2. The purpose of an ac indicating fuseholder is to

   a. provide an alternate current path for the input power.

   b. bleed off excessive input power to the bleeder network.

   c. provides an indication of a good or bad fuse in an ac circuit.

   d. provides an indication of a good or bad fuse in a dc circuit.

c.

The rectified output of the High Voltage Power Supply (A6A1A2) is smoothed out by filter capacitor C1. The output is then applied through the +300 vdc adjust, R3, to the contacts of relay K1. When the RADAR SET CONTROL is set to the ON position 115/120volts ac is applied to the 30 second time delay relay K2. Relay K2 energizes after a 30 second delay and furnishes relay power to energize relays K1 and K3 , permitting the +300 volts dc to be applied to the modulator.

Remember, the high positive dc voltage to the modulator

is not present until after energizing the 30 second time delay relay K2.

NO RESPONSE REQUIRED

3. An excessive amount of load current will result in a blown fuse. The blown fuse will open the circuit and the fuseholder will light up. The schematic symbol for the ac indicating fuseholder is shown below.

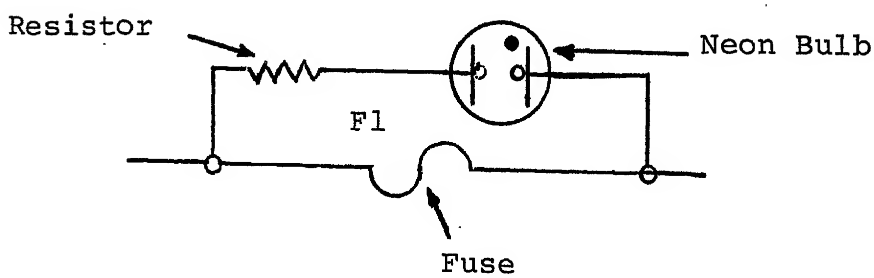


Figure 1

When fuse F1 becomes open due to excessive current, a very small amount of current will then flow through the resistor ionizing the neon bulb. This action causes the neon bulb to glow. Three ac indicating fuseholders are mounted on the RADAR SET CONTROL where the operator of the system can readily observe if the fuse is bad or good.

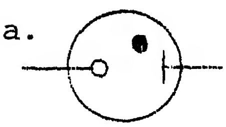
3. (continued)

When the fuse in the ac indicating fuseholder becomes open, the neon bulb will________________.

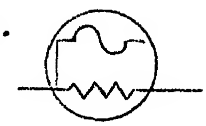
-ght, glow

4. Select the schematic symbol for an ac indicating fuseholder.

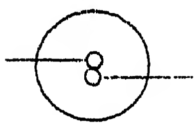
a.



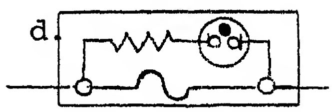
b.



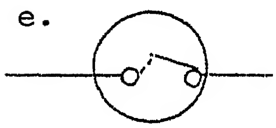
c.



d.



e.



d. 5. When the radar is turned to STBY, it takes approximately 30 seconds before any video is visible on the cathode ray tube or the transmitter can be usdd. Two thermal time delay relays are used in the radar trainer. The purpose of the thermal time delay relays in the modulator and display-indicator power supplies is to provide thirty seconds of delay in the application of the input voltage to the high voltage circuitry.

The thermal time delay relay in the display indicator is used to prevent application of the input voltage to the 7 KV power supply. This allows sufficient time for the filament to heat the cathode so that emission of electrons can occur before application of the 7KV to the CRT.

By preventing the application of the input voltage to the modulator high voltage power

5. (Continued)

supply, no high voltage pulse can be applied to the magnetron. Therefore, the filaments in the magnetron can heat the cathode sufficiently before application of the high voltage pulse to the cathode.

The purpose of the ________ ________ ________ relays is to prevent the application of the ________ ________ to the high voltage circuitry in the display indicator and the modulator until 30 seconds after the radar is turned on.

thermal time delay

input

voltage

6. The purpose of the thermal time delay relays in the display-indicator power supplies is to provide 30 seconds of delay in the application of the input voltage to the:

a. low voltage power supply.

b. high voltage circuitry.

c. receiver.

d. indicator unit.

7. Select the statement that describes the purpose of an ac indicating fuseholder.

   a. Provides a 30 second delay before a fuse opens.

   b. Sense the high voltage overload.

   c. Compensate for surges of input current.

   d. Provides a visual indication of a good or bad fuse in a dc circuit.

   e. Provides a visual indication of a good or bad fuse in an ac circuit.

8. The schematic symbol for the thermal time delay relay used in the modulator power supply is shown in Figure 2 below.

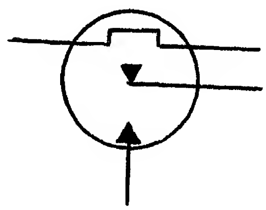


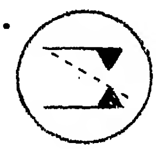
Figure 2

8. (continued)

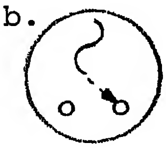
Referring to the schematic of the Modulator Power Supply Group, the thermal time delay relay is designated as K2.

Which of the following symbols is the schematic symbol of a thermal time delay relay as used in the modulator power supply?

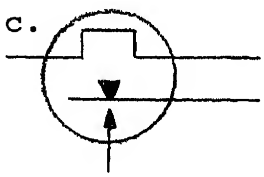
a.



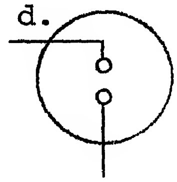
b.



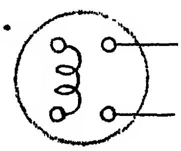
c.



d.



e.

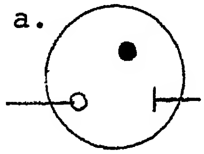


P.I.

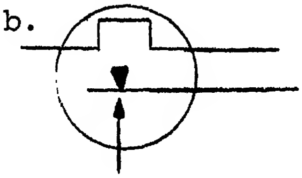
c.

9. Select the correct schematic symbol for the thermal time delay relay.

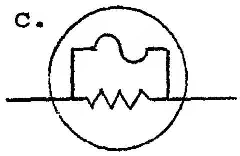
a.



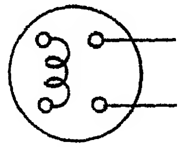
b.



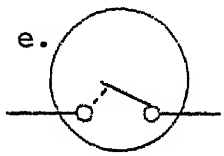
c.



d.



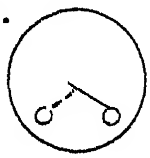
e.



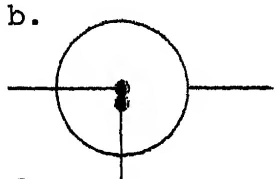
b.

10. Select the schematic symbol for an ac indicating fuseholder.

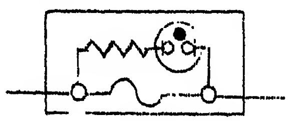
a.



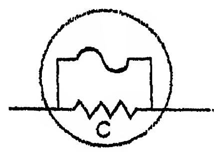
b.



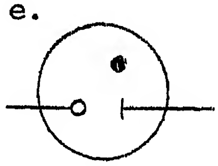
c.



d.



e.



c.

11. Another type of fuseholder used in the modulator power supply is the dc indicating fuseholder. (Refer to Figure 5-19 in the MIM). Fuses XF4, XF5, and XF6 are dc indicating fuseholders. The purpose of these fuseholders is to provide a visual indication of a bad fuse in a dc circuit. When the fuse becomes open, due to excessive current in the circuit, the fuseholder will glow. The dc indicating fuseholder differs from the ac type in that an incandescent bulb is used, instead of a neon bulb. (Notice the difference of the schematic symbol for a neon bulb and an incandescent bulb.)

The purpose of the dc indicating fuseholder is to provide a visual indication of a good or bad fuse in a _______________ circuit.

F.I.

dc

12. The purpose of the dc indicating fuseholder is to provide a visual indication of a good or bad fuse in a(n) ____________ circuit.

a. isolated

b. dc

c. ac

d. overloaded

b.

13. The purpose of the thermal time delay relay is to

a. provide a means of monitoring the high voltage output.

b. provide a 45 second delay of output voltage to the high voltage circuitry.

c. provide a bleeder path for the high voltage power supply.

d. provide a 30 second delay of input voltage to the high voltage circuitry in the display indicator and modulator.

d.

14. The schematic symbol for the dc indicating fuseholder is shown in figure 3 below.

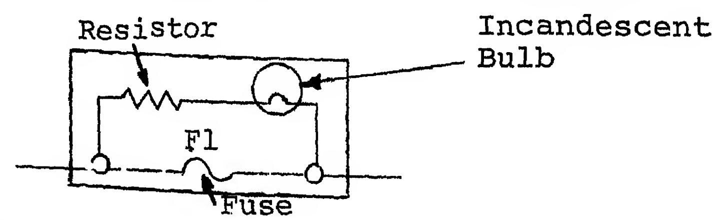


FIGURE 3 - DC INDICATING FUSEHOLDER

P.I.

14. (continued)

When excessive current is present in the circuit, F1 will open, and the dc current will flow through the resistor and the incandescent bulb. Thus, the fuseholder lights up when the fuse is blown. Here again, the radar system operator or technician can visually determine if the fuse is good or bad, without having to remove the fuse from the holder.

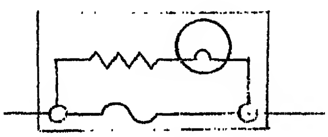
When the fuse opens in a dc indicating fuseholder, the incandescent bulb will ________.

---

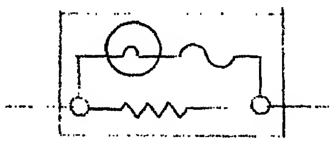
glow, light up, etc.

15. The correct schematic symbol for a dc indicating fuseholder is:

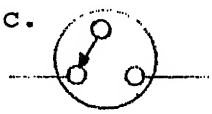
a.



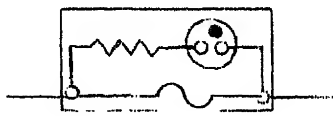
b.



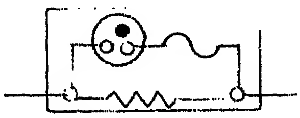
c.



d.

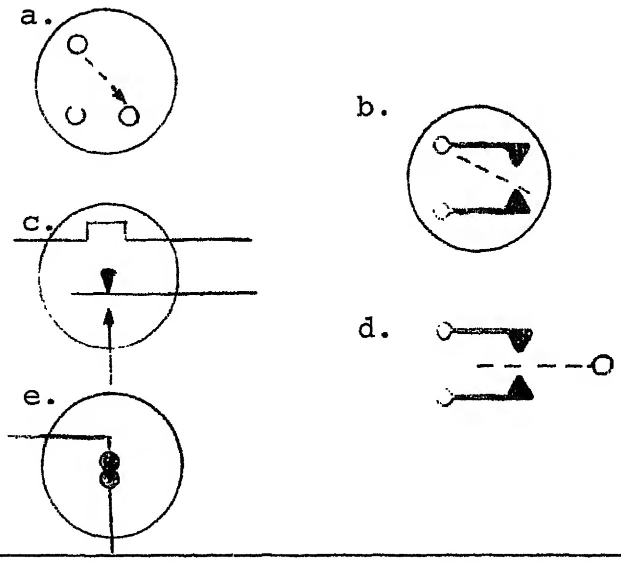


e.



a.

16. The schematic symbol for a thermal time delay relay is:



c.

Before a more complete analysis is made of a three-phase full-wave rectifier a few important points must be stressed. You may ask, "Why are three-phase rectifiers used instead of single phase rectifiers in an airborne search radar system?"

First of all, the three-phase rectifier output requires very little filtering and has good regulation characteristics. The most important advantage of the three-phase rectifier, however, is that it develops

P.I.

higher average voltage and current. Radar systems usually produce large amounts of output power. This is only made possible by using circuits capable of handling large amounts of current.

NO RESPONSE REQUIRED

---

17. The primary operating power for the modulator power supply is controlled by the RADAR SET CONTROL switch A7S1 (Refer to figure 2-21). When S1 is set to STDBY position, 115Vac input power is connected A7 XF1 and A6A1 XF7 to PS-2 and PS-1 which provide +28vdc and (-) and (+) 12vdc respectively. The 115vac input voltage is also coupled to the Klystron Power Supply Card through transformers T5 and T6. Transformer T4 supplies 6.3 and 8.0 volts ac filament power.

When switch A7S1 is switched to the ON position, 208vac 3-phase, 60Hz input power is connected to transformers T1, T2, and T3 through three ac indicating fuseholders A6A1F1, F2, and F3. These transformers are.

17. (continued)

Y-connected to furnish three phase power to the high voltage dc power supply.

High dc voltage for the modulator is produced by a three-phase full-wave rectifier circuit. The output of transformers T1, T2, and T3 are fed directly to the rectifier circuit where each phase is rectified and an output is developed. The purpose of the three-phase rectifier then, is to produce a dc output voltage from the 208Vac, 3-phase input.

The three-phase full-wave rectifier in the modulator power supply produces a ________ voltage output.

---

dc

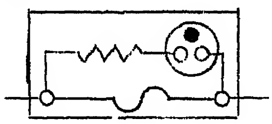
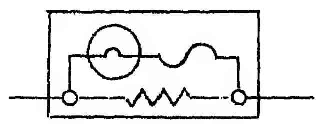
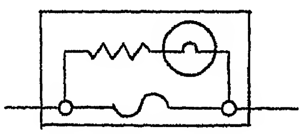
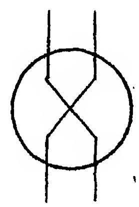
18. The purpose of the three-phase, full-wave rectifier in the modulator power supply is to

a. develop an ac voltage.

b. develop ac and dc voltage from the three phase input.

c. develop a dc voltage from the three phase input.

P.I.	
c.	19. The purpose of a dc indicating fuseholder is to a. sense the inverse current in the overload circuit. b. provide a bleeder path for the low voltage power supply. c. provide a visual indication if the fuse is good or bad. d. provide a 30 second time delay for the high voltage circuit. e. provide a visual indication of a bad or good fuse in an ac circuit.
c.	20. The components that make up the three-phase full-wave rectifier are designated as CR4 through CR9 in the modulator power supply (Refer to the schematic of the High Voltage Power Supply, fig. 5-21.) Phase A is coupled from the secondary of T2 to the junction of CR4 and CR7. Phase B is coupled from the secondary of T1 to the junction of CR5 and CR8. Phase C is coupled from the secondary of T3 to the junction of CR6 and CR9. Each phase is then rectified and the dc output is fed to the modulator circuits.

P.I.	
	20. (continued) The three-phase full-wave rectifier in the modulator power supply is comprised of diodes CR___ through CR_____.
4, 9	21. The components used in the three-phase, full-wave rectifier circuit are a. CR4 through CR9 only. b. CR5 through CR8. c. CR1 through CR4 only.
a.	22. Select the schematic symbol for a dc indicating fuseholder. a.  b.  c.  d. 

P.I.

c.

23. Most airborne search radar systems incorporate an overload protection circuit in the Modulator Power Supply. This overload protection circuit serves a specific purpose in the radar system, as it removes the high voltage (+300Vdc) from the modulator when the applied voltage exceeds the predetermined value or an overload exists in the PFN. With the high voltage removed from the modulator, the transmitter will not produce the rf energy that is required for proper system operation.

The purpose of the overload protection circuit in the modulator power supply is to remove the +____________ from the __________ when the applied voltage exceeds the predetermined value or an overload exists in the ____________________.

300Vdc modulator PFN

24. Select the statement that describes the purpose of the overload protection circuit.

a. Supply a ground to energize the HV ON and STDBY indicator lights.

b. Energize the thermal time delay circuit.

c. Remove the 300Vdc from the modulator when the applied voltage exceeds the predetermined value or when an overload exists in the PFN.

d. Remove the 300Vac from the modulator when the applied voltage exceeds the predetermined value or when an overload exists in the PFN.

e. Provide protection for the power supply when a mismatch occurs within the PFN, magnetron or waveguide sections.

---

c.

25. The purpose of the three-phase, full-wave rectifier is to

a. provide an attenuated measurement point for the +300Vdc.

b. produce a dc output voltage from the 208Vac three-phase input.

c. filter out emitter voltage variations on Q2.

d. provide an ac output voltage.

---

b.

26. The overload adjust R2 and R5, transistor Q1, and relay A6A1K1 comprise the overload protection circuit. These components are

26. (continued)

shown on the Modulator Power Supply schematic, figure 2-21.

Q1 is normally held cutoff by the bias applied from overload adjust R2. If the incoming voltage exceeds the predetermined value, Q1 will conduct, causing overload control relay A6A1K1 to energize. This energizes relay A6A1A2K2, which causes A6A1A2K1 and K3 to deenergize, removing the +300 vdc from the modulator. A6A1A2K2 will remain energized until the radar is turned to OFF.

The components included in the overload protection circuit are overload adjust R_____ and R5, transistor Q______, and relay A6A1K____.

R2, Q1
A6A1K1

27. The components included in the overload protection circuitry are

a. CR5, CR8, K3.

b. CR4 through CR9.

c. Q2, VR3, R10, R11, R3.

d. R2, R5, Q1, A6A1K1.

d.

28. Which of the following components are in the three-phase full-wave receifier circuit?

    a. CR1 through CR4.

    b. CR5 through CR8.

    c. VR6, VR7, Q3, R4.

    d. CR4 through CR9.

d.

29. Another significant circuit included in the modulator power supply group is referred to as the inverse current sensing network. The purpose of the inverse current sensing network is to provide protection for the power supply when a mismatch occurs within the magnetron, waveguide section or antenna. Refer to the schematic of the Modulator Power Supply Group, figure 5-19, for the following circuit analysis.

P.I.

29. (Continued)

The inverse current sensing network consists of the inverse current diode A6A1A4CR2, inverse current relay (A6A1K3), and the inverse current meter A6A1M2. The inverse current meter is mounted in series with the coil of inverse current relay A6A1K3, and indicates the power supply inverse current.

The components in the inverse current sensing circuit are A6A1A4________, A6A1_____, and meter A6A1M2.

CR2
K3

30. Select the components that make up the inverse current sensing circuitry. (Select three)

a. A6A1A4 CR2.

b. Meter A6A1M2.

c. R1 & L1.

d. Relay, A6A1 K2.

e. Relay A6A1 K3.

P.I.	
a. b. e.	31. The purpose of the overload protection circuit is to a. remove the 100Vac from the receiver when the applied voltage exceeds the predetermined value. b. energize the thermal time delay circuit. c. remove the +300Vdc from the modulator when the applied voltage exceeds the predetermined value or when an overload exists in the PFN. d. provide protection for the power supply when a mismatch occurs within the PFN, magnetron, or waveguide sections.
c.	32. When a mismatch occurs in the radar system transmitter, waveguide sections or antenna, most of the energy is reflected back into the high voltage circuits in the form of an inverse current. When the system is operating properly, some small amount of inverse current is present in these circuits. The inverse current meter, M2, on the front of the A6 unit monitors this inverse current. A normal reading of approximately 0.2 milliamperes is seen on the meter during transmitter operation.

P.I.	
	32. (continued) When the radar is operating properly, the reading on the inverse current meter will be approximately ________ma.
0.2	33. A reading of 0.2ma is considered a ________ normal/ ____________ abnormal reading on the inverse current meter M2, with the system operating properly.
normal	34. The components included in the overload protection circuit are a. CR4, CR8, C1, T4, S3. b. CR1 through CR4. c. Q2, VR3, R10, R11. d. R2, R5, A6A1K1, Q1.
d.	35. When a mismatch does occur in the magnetron, waveguide, or antenna, the reflected energy will cause a greater amount of inverse current to be present in the high voltage circuit and across meter

35. (Continued)

M2. The increase in inverse current will cause the inverse current relay A6A1K3 to energize, using contacts 6 and 8. This applies +28vdc to relay A6A1A2K2, causing it to energize.

With more than 0.2ma of inverse current, relay A6A1K3 energizes, applying a + _____Vdc to relay A6A1A2K_____.

28
2

36. With more than ____________ma of inverse current, relay A6A1K3 energizes, applying a +28Vdc to relay A6A1A2K __________.

0.2
2

37. Refer to the schematic diagram of the modulator power supply.

Select the components in the Inverse Current sensing circuit.

a. Q1, R4, K8, R6.

b. K4, R4, CR1, CR2.

c. A6A1A4CR2, Meter M2, A6A1K3.

d. A6A1M4, T7, A6A1A1Q1.

e. CR4, L1, R5, R1.

P.I.	
c.	38. Refer to figure 2-21. Energizing relay A6A1A2K2 then causes the relays A6A1A2K1 and A6A1A2K3 to de-energize, thereby removing the +300 vdc from the modulator. A6A1A2K2 will remain energized until the radar is turned to OFF. All of the preceeding actions take place in sequence, thus removing the high voltage from the charging circuit of the pulse forming network (see figure 5-19). With the high voltage to the pulse forming network removed the PFN will not charge, the magnetron will not fire, and there will be no rf power output from the transmitter. When relay A6A1A2K1 de-energizes, the high voltage is removed from the ______________ ______________________________.
pulse forming network	39. When relay A6A1A2K1 de-energizes, the high voltage is removed from the ______________________________. pulse forming network/magnetron

P.I.	
pulse forming network	40. When the radar is operating properly, the reading on the inverse current sensing meter will be a. 0.48ma or more. b. 0.2ma or less. c. 1.3ma or more. d. 2.0ma or more.
b.	41. With more than 0.2ma of inverse current in the overload circuit (select two) a. K8 energizes. b. relay A6A1A2K2 de-energizes. c. relay A6A1K3 energizes. d. high voltage relay A6A1A2K1 energizes. e. relay A6A1A2K2 energizes.
c, e	42. When relay A6A1A2K1 de-energizes, the high voltage is removed from the a. STC circuit. b. pulse forming network. c. pulse transformer. d. dual TR tube. e. 1kHz oscillator.

b. At this point, you may take the lesson topic progress check. You may find it beneficial to review the objectives for this lesson topic. If you answer all self-test items correctly, go on to the next lesson topic. If not, select and use another medium of instruction, narrative, or consultation with the learning supervisor, until you can answer all self-test items on the progress check correctly (achieve lesson topic learning objectives) and then proceed to the next lesson topic.

AVIONICS TECHNICIAN COURSE, CLASS A1

UNIT 5

MODULE 6

LESSON TOPIC 2

PULSE FORMING NETWORK AND SCR CONTROL CIRCUITS

NOVEMBER 1975

OVERVIEW

LESSON TOPIC 5-6-2

PULSE FORMING NETWORK AND SCR CONTROL CIRCUITS

In this lesson topic you will be familiarized with the Pulse Forming Network (PFN) in the modulator section of the Airborne Search Radar System Trainer. A thorough understanding of the PFN and its associated circuitry will enable you, as a technician, to effectively troubleshoot the modulator section of most airborne search radar systems. A semiconductor device known as a Silicon Controlled Rectifier (SCR) will also be explained in this lesson. Facts concerning the SCR to be covered will be its principle of operation, and its application to the Modulator Circuit and the Pulse Forming Network.

In the succeeding pages the SCR will be explained first, and then the Pulse Forming Network. Be sure you understand the information presented as it is most important in the operation of the radar system transmitter.

The learning objectives for this lesson topic are as follows:

1. Select from a list the statement that describes the purpose of the Pulse Forming Network used in the pulse type radar.
2. Select from a list the statement that describes two properties of transmission lines that are combined to form an artificial line.
3. Select from a list the components in the Pulse Forming Network that affect the shape and duration of the output pulse.
4. Select the symbol of the Pulse Forming Network from a group of schematic symbols.
5. Given a block illustration of the SCR, select the proper location of the anode, gate, and cathode of an SCR.
6. Select from a list the correct block illustration that represents the structure of an SCR.
7. Select from a list the method of biasing that is required to properly bias an SCR for cutoff.
8. Select the symbol of an SCR from a list of schematic symbols.
9. Select from a list the statements that describe the electrical properties of an SCR.

10. Select from a list the statements that describe why the SCR is utilized in radar modulators.

11. Select from a list the reference designators for the SCR and the Modulator Control Circuit Card.

12. Select from a list the statement that describes the function of the SCR control circuitry.

13. Select from a list the statement that describes when the SCR conducts to discharge the PFN.

14. Select from a list the statement that describes the function of the charging inductor.

15. Select from a list the components that are included in the charge path of the Pulse Forming Network.

16. Select from a list the components that are included in the discharge path of the Pulse Forming Network.

17. Select from a list the statement that describes the function of the holding diode, CR1, in the A6A1A4 assembly.

NOTE: All objectives in this lesson topic must be accomplished with 100 percent accuracy, unless otherwise stated.

Prior to beginning this lesson topic, carefully review the "List of Study Resources". Keep in mind that your learning supervisor can be your most valuable learning resource. Always feel free to consult with him if you have problems or questions.

LIST OF STUDY RESOURCES

LESSON TOPIC 5-6-2

PULSE FORMING NETWORK AND SCR CONTROL CIRCUIT

To learn the material in this lesson topic, you may choose, according to your experience and preferences, any or all of the following written lesson topic presentations.

WRITTEN LESSON TOPIC PRESENTATIONS IN MODULE BOOKLET:

1. Lesson topic summary.
2. Programmed instruction form of lesson topic.
3. Narrative form of lesson topic.
4. Lesson topic progress check.

ADDITIONAL MATERIALS REQUIRED FOR SUCCESSFUL COMPLETION OF LESSON TOPIC:

1. Job program in Job Program Booklet.
2. Student response sheet
    a. Answer sheet for use with test.
    b. Programmed instruction response sheets.

ENRICHMENT MATERIAL:

15A21 MIM.

All the resources listed above are available and may be used as you see fit. Your learning supervisor represents a most valuable learning resource. Use him when you need help. It is not necessary to use all the resources to achieve the learning objectives for the lesson topic. The lesson topic progress check is your means of determining when you have achieved the objectives. The progress check may be taken at any time and is graded by you. If you fail to achieve any objective at the lesson topic level, you will plan and accomplish your own remediation. If you need help in remediation planning, consult your learning supervisor.

PROGRAMMED INSTRUCTION

PULSE FORMING NETWORK AND SCR CONTROL CIRCUIT

INTRODUCTION

A radar modulator, controls the transmitters development of radio-frequency (rf) energy in short powerful pulses. A pulsed modulator controls the shape and duration of the output rf pulses. Usually, the modulator exercises control by applying high-voltage pulses to the cathode of the rf generating device (called a magnetron).

Radar systems that require accurate range measurement require the transmitted rf pulse to have a steep leading and trailing edge. The leading edge is used for target range measurement. If the leading edge of the echo is not steep and clearly defined, accurate range measurement is not possible. Remember, the leading and trailing edges of target echoes have the same shape as the leading and trailing edges of the transmitted rf pulse.

A transmitted rf pulse with a steep trailing edge is essential for detecting targets at short ranges. If the modulator high voltage output were to drop from maximum value to zero, the output of the magnetron (rf energy) would do the same. This is why the modulator is very important in the radar system.

The most commonly used modulator circuit is the line-pulsed modulator. This circuit stores energy and forms a dc pulse. The line pulsed modulator is very efficient, less complex, less sensitive to input voltage changes, and requires a lower supply voltage than other type modulator circuits. The line pulsed modulator is also easier to maintain because of its less complex circuitry and, for a given amount of power output, it is more compact and light.

Figure 1 shows the basic components of a line-pulsed modulator, including the modulator high voltage power supply. Note that the components of the radar modulator are as follows:

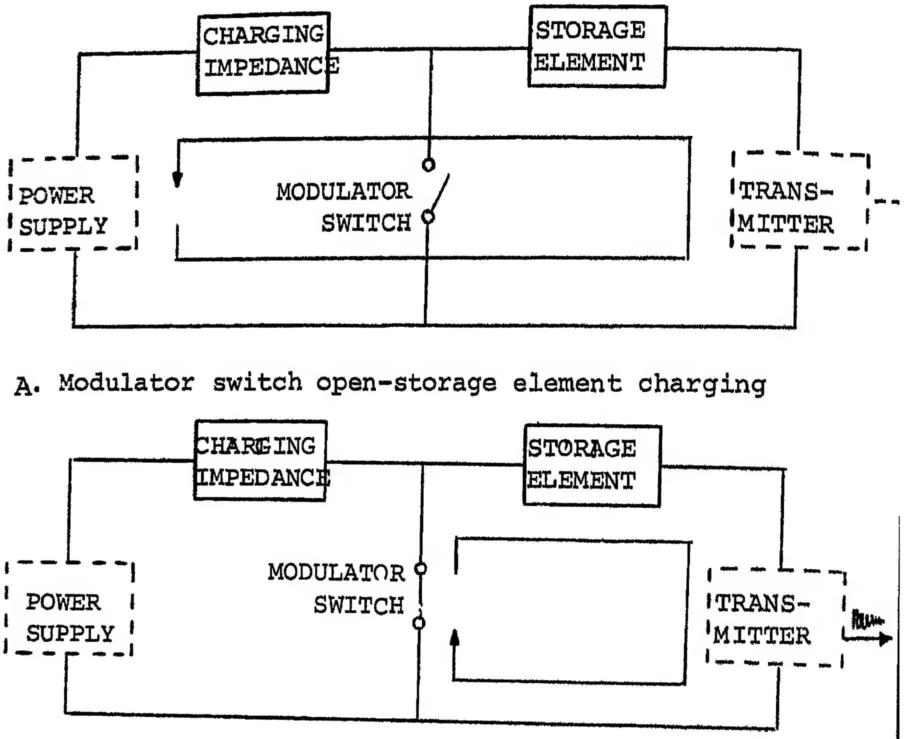
a. a storage element used for storing voltage.

b. a charging impedence to control the charge time of the storage element and to prevent short-circuiting of the power supply during the modulator pulse.

c. a modulator switch to discharge the energy stored by the storage element through the magnetron (transmitter) during the modulator pulse.

Figure 1(A) shows the modulator switch open and the storage element charging. With the modulator switch open, the transmitter produces no output power, and the storage element charges to a high voltage. Figure 1(B) shows the switch closed and the storage element discharging through the transmitter. The energy stored by the storage element is released in the form of a high-power dc modulator pulse. The transmitter then converts the dc pulse to an rf pulse, which is radiated

Introduction (Continued)



A. Modulator switch open-storage element charging

B. Modulator switch closed- storage element discharging

FIGURE 1

into space by the antenna. Thus, the modulator switch is closed for the duration of the transmitted rf pulse, but is open when the storage element is charging.

NO RESPONSE REQUIRED

P.I.

1. The modulator storage element is called a pulse-forming network (PFN). The PFN is essentially an artificial transmission line, consisting of identical capacitors and inductors capable of voltage storage. The purpose of the pulse-forming network is to develop a high dc voltage pulse that is to be applied through a pulse transformer to the magnetron. The magnetron then produces the rf energy that is fed to the antenna.

   The purpose of the pulse forming network (PFN) is to develop a ___________ __________ ___________ ________ that is applied through the pulse transformer to the magnetron.

high
dc
voltage
pulse

2. The purpose of the pulse forming network is to

   a. generate a high dc voltage to the antenna.

   b. develop a high ac voltage pulse to the pulse transformer.

   c. supply the radar timing pulse.

   d. develop a high dc pulse that is applied through the pulse transformer to the magnetron.

3. The schematic symbol of the pulse forming network used in the airborne search radar system trainer is shown on the schematic sheet of the modulator figure 2, at the end of the progress check. The shaded area designated "A" is the PFN.

The PFN is comprised solely of capacitors and inductors that are combined to form an artificial transmission line. The components are grouped for series inductance and shunt capacitance. Although these are properties of transmission lines, they are combined to form an artificial transmission line.

The pulse forming network is an artificial transmission line that contains ______________ inductance, and ______________ capacitance.

series
shunt

4. The two properties of transmission lines that are combined to form an artificial line are series

______________________ and
inductance/capacitance

______________________ capacitance.
series/shunt

P.I.

inductance
shunt

5. The pulse forming network (PFN) develops a ____________ voltage dc pulse that is applied through the pulse transformer to the magnetron.

high

6. As previously stated, two purposes of PFN are to store voltage when the modulator switch is open, and to discharge the voltage to form a high voltage dc pulse of the required duration when the modulator switch is closed. The duration of the modulator pulse depends on the values of inductance and capacitance in each LC section of the artificial transmission line, and the number of sections used.

The ____________ and ____________ in the PFN affect the shape and duration of the output pulse.

inductors
capacitors

7. The components in the PFN that affect the shape and duration of the output pulse are:

   a. transistors, inductors

   b. capacitors, transistors

   c. inductors, resistors

   d. capacitors, inductors

   e. capacitors, resistors

---

d

8. The purpose of the PFN as used in the pulse type radar is to

   a. supply the 1 kHz sync trigger to the magnetron.

   b. generate trigger pulses for the time delay.

   c. develop a high voltage ac pulse to be applied to the magnetron.

   d. develop a high voltage dc pulse applied through the pulse transformer to the magnetron.

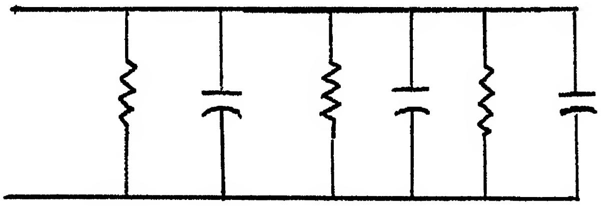
P.I.

d

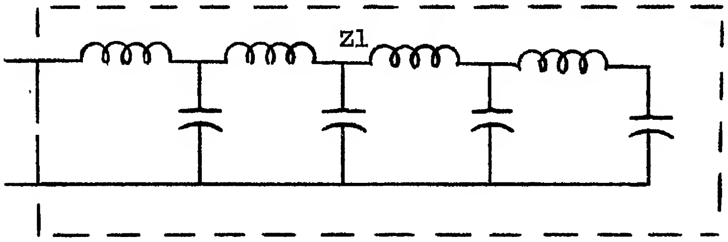
9. Remember, that the inductors and capacitors in the shaded area on figure 2 are combined to form the pulse forming network. Thus, the schematic symbol for the PFN includes the inductors and capacitors.

The symbol for the PFN is which of the following?

a

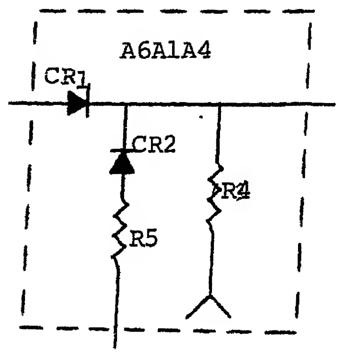


b

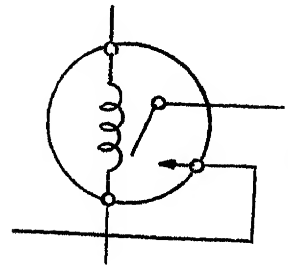


10. Select the schematic symbol of the pulse forming network.

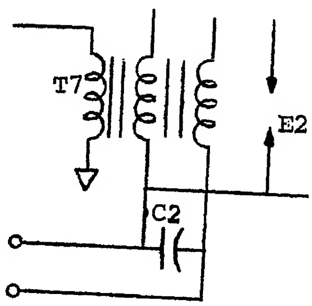
a.



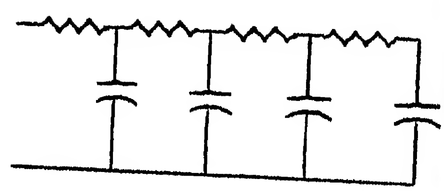
b.



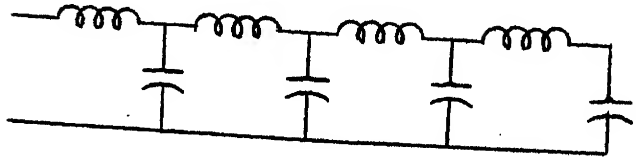
c.



d.



e.



P.I.

e

11. Two properties of transmission lines that are combined to form an artificial line are

    a. shunt capacitance, parallel inductance.

    b. series inductance, series capacitance.

    c. parallel inductance, series capacitance.

    d. series inductance, shunt resistance.

    e. series inductance, shunt capacitance.

e

12. Which components in the PFN affect the shape and duration of the output pulse?

    a. relays, inductors

    b. inductors, resistors

    c. capacitors, inductors

    d. capacitors, resistors

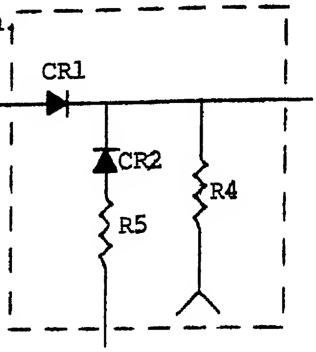
    e. resistors, relays

P.I.

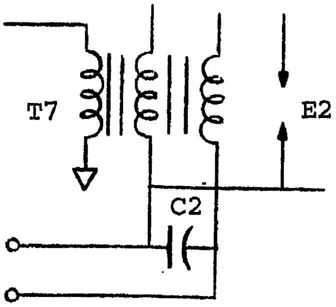
c.

13. Select the schematic of a pulse forming network.

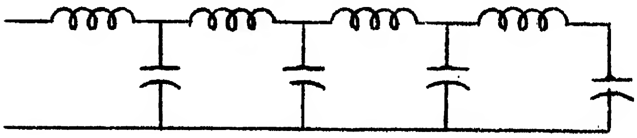
a.



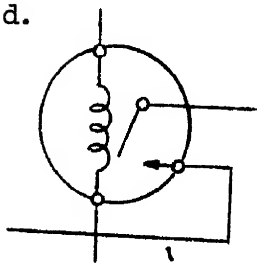
b.



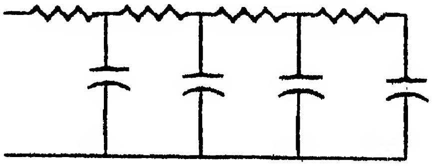
c.



d.



e.



Now that you know the purpose of, and the components in the pulse forming network, let's continue on and evaluate the other components associated with the PFN. After all of the components have been

thoroughly covered and their function/ purpose understood, a complete analysis of the charge and discharge of the PFN will be explained.

In figure 1, an explanation was given pertaining to the charge and discharge of the PFN. The most important part of the circuit that allowed this charging and discharging sequence to occur was the action of the modulator switch. The voltage stored by the PFN must be discharged through the switching device for proper operation of the transmitter. The switching device must then conduct for the duration of the modulator pulse, and must be open between pulses. Thus, the modulator switch must perform the following functions:

a. Close suddenly, and reach full conduction in only a few nano seconds.

b. Cease conducting with the same speed that it started to conduct.

c. Consume only a very small fraction of the current that passes through it.

d. Conduct large currents, and withstand high voltages.

The switching device used in the airborne search radar system trainer is the Silicon Controlled

Rectifier (SCR). It is shown in the shaded area B of figure 2. The basic theory of operation of the SCR will now be covered.

NO RESPONSE REQUIRED

14. The Silicon Controlled Rectifier (also called a PNPN device, Thyristor or Controlled Rectifier) is a four-layer semiconductor device, with a structure of the form shown below (figure 3).

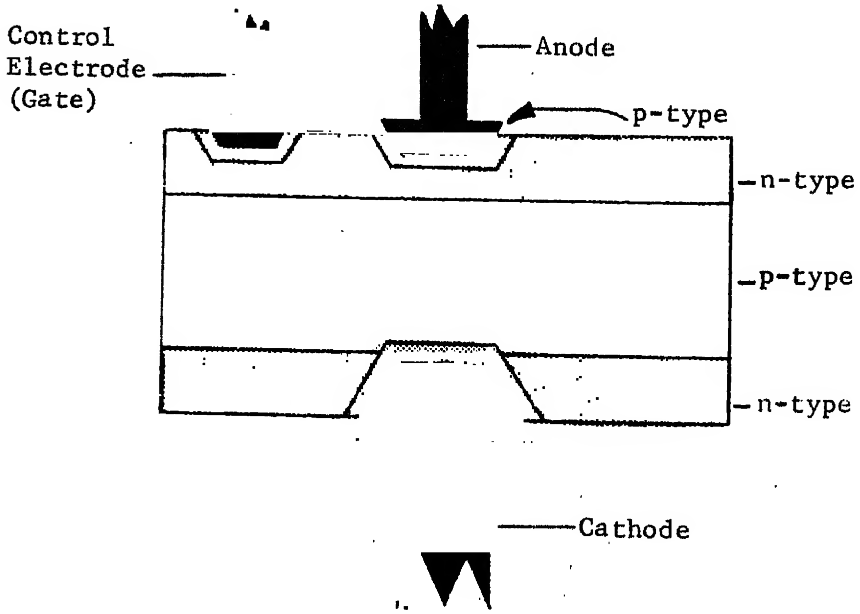


FIGURE 3: CONSTRUCTION OF A CONTROLLED RECTIFIER

14. (Continued)

It can be represented more simply by the structure block illustration at figure 4.

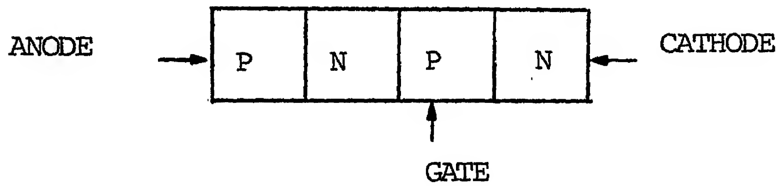
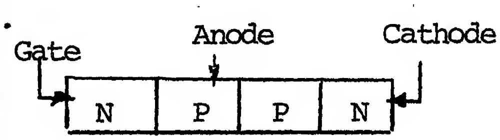
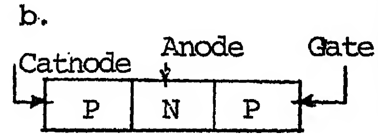


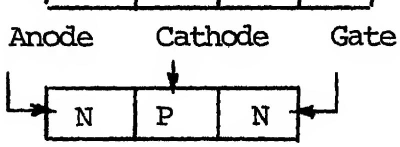
FIGURE 4: Silicon Controlled Rectifier (SCR)

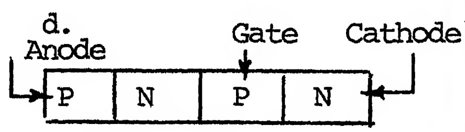
The rectifier has two stable states, one in which the internal resistance is very low (the conductive state) and the other in which the internal resistance is very high (the non-conductive state). The device can be switched very rapidly from non-conduction to conduction with little power being needed to bring about this change of state.

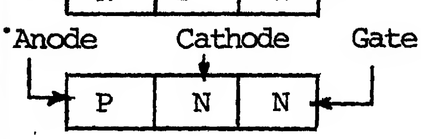
Select the proper location of the anode, gate, and cathode of an SCR.

a.


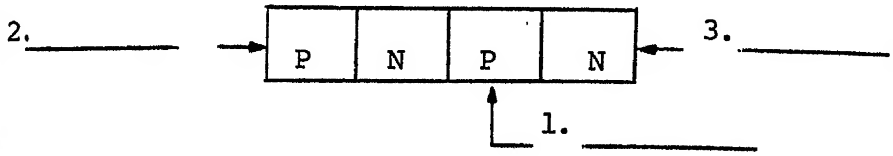
b.


c.


d.


e.


15. Label the block illustration of an SCR with respect to the location of the gate, anode, and cathode.



1. gate
2. anode
3. cathode

16. Refer to the SCR structure block illustration (Figure 5). It can be seen that there are three PN junctions. These junctions are referred to

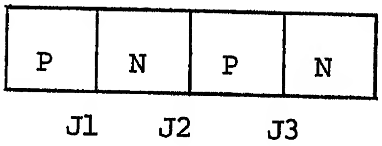


FIGURE 5

respectively as J1, J2, and J3. Through proper biasing of these junctions, the SCR will prove to be a very dependable switching device.

The SCR device has ______________ PN junctions.

three

17. Which of the below is the correct block illustration representing the structure and correct number of junctions of an SCR?

a.

P	N

J1

b.

P	N	P

J1 J2

c.

P	N	P	N

J1 J2 J3

d.

N	P	N	N

J1 J2 J3

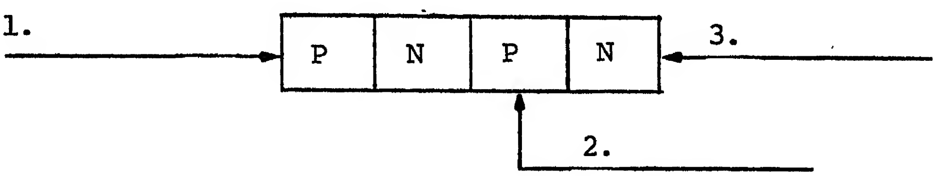
e.

P	P	N	P

J1 J2 J3

c

18. Refer to the figure below and select the location of the anode, gate, and cathode of an SCR.



see next page

18. (Continued)

a. 1-anode, 2-cathode, 3-gate

b. 1-cathode, 2-gate, 3-anode

c. 1-anode, 2-gate, 3-cathode

d. 1-gate, 2-anode, 3-cathode

e. 1-gate, 2-cathode, 3-anode.

---

c

19. The SCR is biased similarly to a conventional diode. Remember that a negative potential on the n-type material, and a positive potential on the p-type material will always forward bias a PN junction. Keep this in mind as you refer to figure 6.

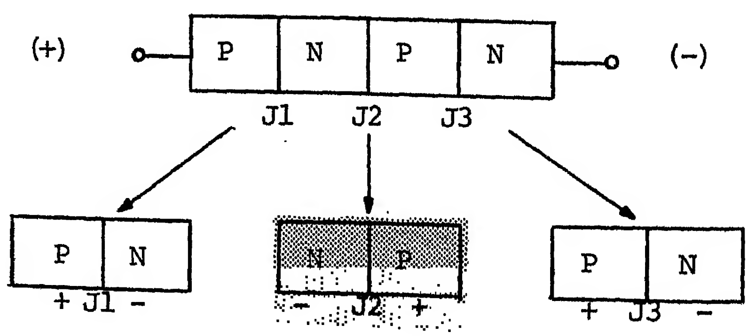


FIGURE 6: Forward Biased SCR

19. (Continued)

Under the conditions of bias shown for the three junctions, the SCR will conduct, as all three junctions are in the forward bias condition. During conduction, the internal resistance of the SCR is only a few ohms.

To switch the SCR to the "off" state, the J2 junction must be reverse biased as shown in figure 7.

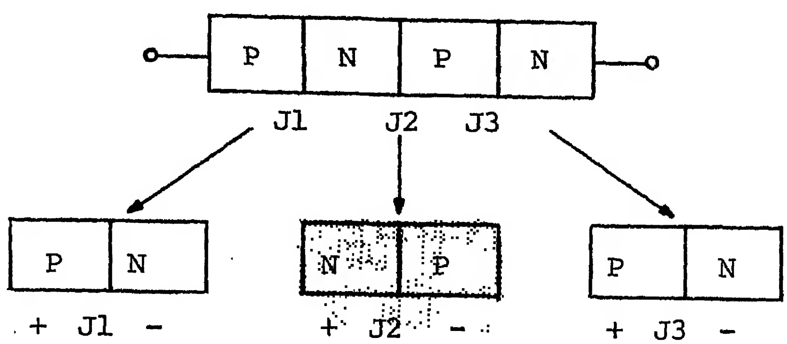


FIGURE 7: Reverse Biased SCR

Under the condition of reverse bias a "blocking action" is caused at the J2 junction. Because of this reverse bias condition of J2, the resistance of the SCR is extremely high—on the order of several hundred megohms. Thus, the SCR is non-conducting.

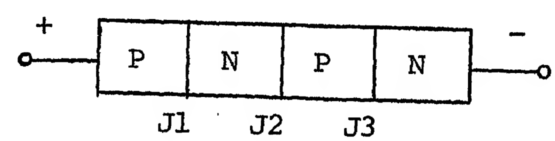
You can see that through the two methods of biasing the SCR will act as a switch.

19. (Continued)

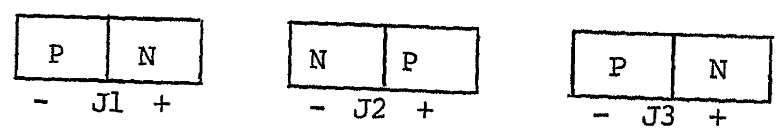
To properly bias an SCR so that it will not conduct, the junction J2 must be ____________ biased.

REVERSE

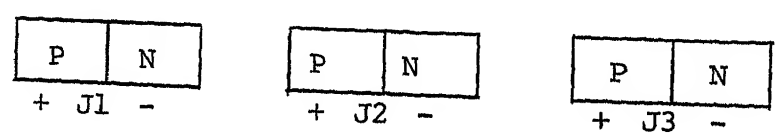
20. Refer to the figure below, and select the method of biasing required to properly bias an SCR for cutoff (non-conducting).



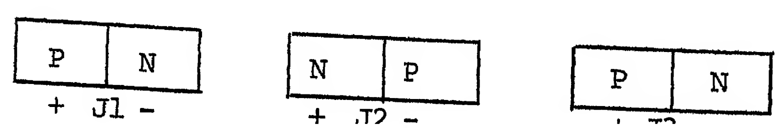
a.



b.



c.



c

21. The correct block illustration that represents the structure and number of junctions of an SCR is which of the below illustrations?

a.

N	P	N	P

J1 J2 J3

b.

P	N	P	N

J1 J2 J3

c.

N	N	P	P

J1 J2 J3

d.

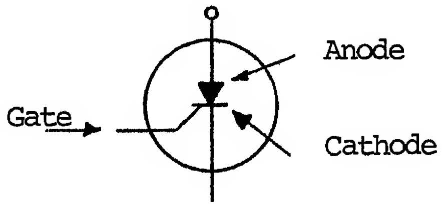
P	N	P

J1 J2

---

b

22. The schematic symbol for a silicon controlled rectifier is basically that of a diode with the addition of the gate lead. Refer to figure 8.



FIG

The end P and N-

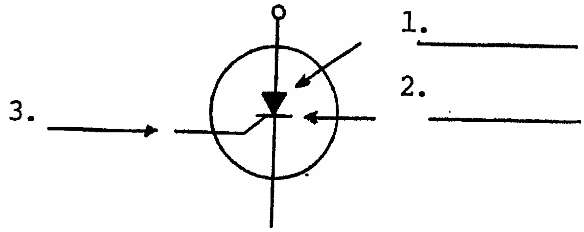
arrowhead and ba

drawn at approxi

22. (Continued)

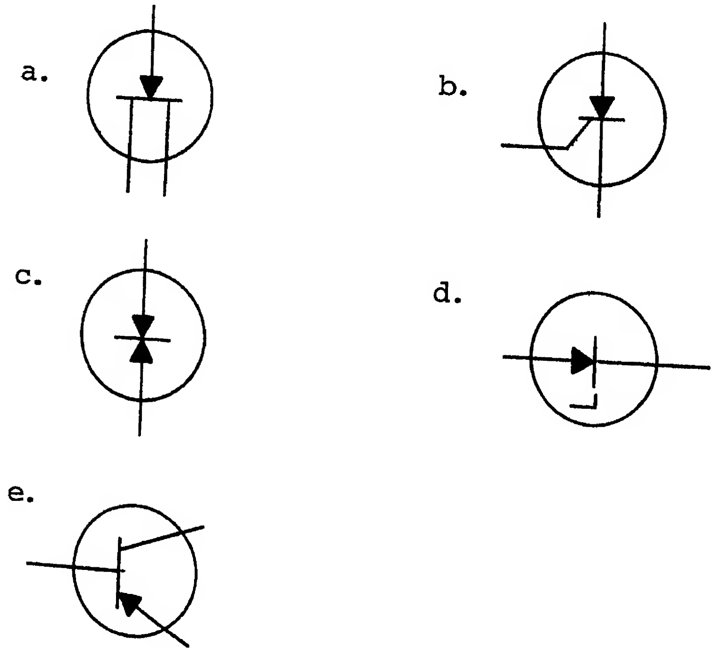
cathode. Current will always flow against the arrow--from the cathode to the anode.

Label the parts of an SCR on the below SCR symbol.



1. anode
2. cathode
3. gate

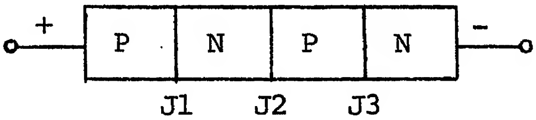
23. Select the schematic symbol of an SCR from the symbols below.



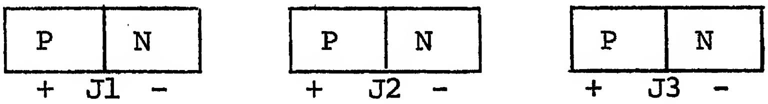
P.I.

b

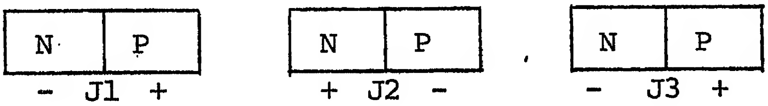
24. Refer to the figure below and select the method of biasing required to properly bias a SCR for cutoff.



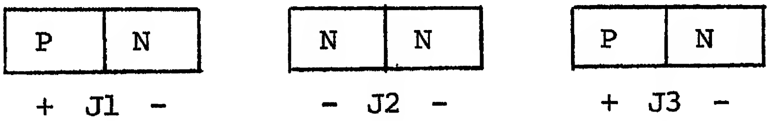
a.



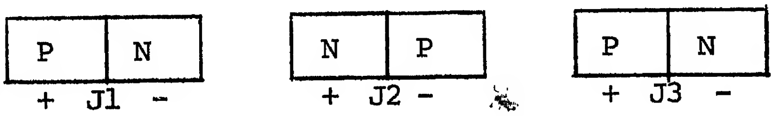
b.



c.



d.



25. Analyzing the information already presented on the SCR, a conclusion can be drawn as to the electrical properties of the SCR. First, the SCR has unidirectional current flow, meaning that current will flow through the device in one direction only—against the arrow. Second, the anode must always be positive with respect to the cathode for the SCR to conduct. Last, but not least, conduction and cutoff can be controlled by proper biasing of the gate junction.

Complete the following statements:

The SCR has ______________ current flow, and the anode must always be ________________ with respect to the cathode to cause conduction.

_______________ and _______________ can be controlled by proper biasing of the gate junction.

ional

26. Select the three statements that describe the electrical properties of an SCR.

ıode must be negative with respect to the le.

b. The anode must be positive with respect to the cathode.

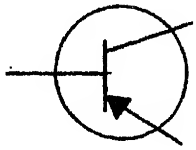
c. Conduction and cutoff can be controlled by proper biasing.

d. It has unidirectional current flow.

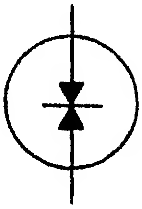
b.
c
d

27. Select the schematic symbol for a SCR from the list below.

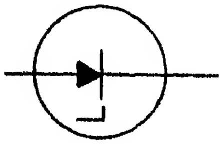
a.



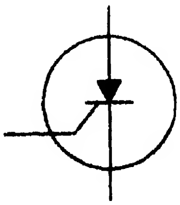
b.



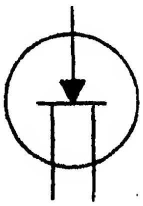
c.



d.



e.



F.I.

d.

28. An important point to remember about the SCR is how it is used in conjunction with the pulse forming network. Without the SCR in the circuit the PFN would never be able to discharge its stored voltage.

Simply, the SCR is used as an electronic switch to provide a discharge path for the PFN.

The SCR is used in the modulator as an electronic ______________, to provide a ____________ path for the PFN.

switch
discharge

29. Select two statements that describe the use of the SCR in the radar modulator.

a. As a mechanical switch.

b. To provide a charging path for the PFN.

c. As an electronic switch.

d. To allow relay K3 to energize.

e. To provide a discharge path for the PFN.

c
e

30. Select three statements that describe the electrical properties of an SCR.

a. a negative pulse applied to the gate will cause conduction.

b. the anode must be negative with respect to the cathode.

c. the anode must be positive with respect to the cathode.

d. conduction and cutoff can be controlled by proper biasing.

e. it has unidirectional current flow

c
d
e

Up to this point in the lesson, you have studied the components of the PFN, and the SCR semiconductor controlling device. Before a complete analysis is given on the charge and discharge sequence of the PFN, we will briefly cover how and when the SCR is triggered in the modulator circuit. Remember, the triggering of the SCR will forward bias it and allow the PFN to discharge the stored voltage.

NO RESPONSE REQUIRED

31. The trigger used to initiate conduction of the SCR (Q1) is generated by circuits in the synchronizer and arrives at the SCR via the Modulator Control Circuit Card A6A1A1. Refer to Figure 2 at the end of the Progress Check booklet. The purpose of this control circuitry is to, in the SYStem operation mode, couple the 1kHz clock trigger from the synchronizer unit to the SCR. In the INDEPendent operation mode, a 1kHz clock trigger is generated by Q1 and the associated circuitry. The clock trigger from the synchronizer is disconnected when using the INDEP operation mode. NOTE: The only time that INDEP operation is used (within this course of study) would be for the purpose of generating a clock trigger to gate the SCR and discharge the PFN if the synchronizer clock trigger were inoperative. The switch will normally be kept in the SYS operation mode position.

The reference designators for the SCR and for the Modulator Control Circuit Card are A6A1Q ______ and A6______.

P. I.

A6A1 Q1
A6A1A1

32. The reference designators for the SCR and Modulator Control Circuit Card are A6A1Q1 and A6A1A1. TRUE/FALSE

true

33. Select two statements that describe why the SCR is utilized in the radar modulator.

a. The SCR can be used as an electronic switch.

b. the SCR allows the pulse transformer to charge continuously.

c. The SCR permits operation c. the overload relays.

d. The SCR can be used to provide a discharge path for the PFN.

a
d

34. The most important point to remember about the Modulator Control Circuit Car A6A1A1, is that it contains the SCR control circuitry. This circuitry will generate a 1 kHz clock trigger when INDEP OPN is selected, or route the clock trigger from the synchronizer unit to the SCR. The latter method normally will be used, and switch :1 will usually be placed in the SYS OPN (system operation) position.

P.I.	
	34. (Continued) The function of the SCR control circuitry is to, in the SYS OPN mode, route the 1kHz clock trigger directly to the SCR. true/false
true	35. The function of the SCR control circuitry is to couple the 1kHz clock trigger to the SCR, in the SYStem operation mode. true/false
true	36. Select the reference designaters for the SCR and the Modulator Control Circuit Card. a. A6A1Q1, A6A1A2 b. A6A2A1, A6A1Q1 c. Q1, A6A1A3 d. A6A1Q1, A6A1A1. e. A6A1Q1, A6A1A4

P.I.	
d	37. The 1kHz clock trigger leaves the A6A1A1 circuit card and is applied to the gate of the SCR. Conduction now takes place in the SCR. Remember that the clock trigger is a positive gate and it will forward bias the SCR. Acting as a switch, the SCR will discharge the voltage stored by the PFN. The SCR conducts to discharge the PFN when a 1kHz clock trigger is applied to the ________ of the SCR.
gate	38. The SCR will conduct and discharge the PFN when the ____________ clock trigger is applied to the gate lead.
1 kHz	39. The function of the SCR Control Circuitry is that a. it limits the voltage applied to the spark gap. b. +28vdc initiates operation of Q1 in the SYS OPN mode. c. in the SYS OPN mode, the 1kHz clock trigger is applied directly to the SCR. d. it requires no additional circuitry to function.

P.I.	
c	40. The SCR conducts to discharge the PFN when a. the HV terminates. b. K3 becomes energized. c. a 1kHz clock trigger is applied to the gate. d. provided with a 28vdc pulse from the synchronizer.
c	At this time, the information previously presented on the PFN, SCR, and the SCR Control Circuit will be reviewed so that you can actually visualize how the modulator functions in providing the high voltage pulse to the magnetron. Other important components associated with the SCR and PFN will be explained, as to their purpose/function in the circuit. A complete analysis will also be given of the electrical charge and discharge sequence of the PFN. NO RESPONSE REQUIRED

41. Refer to figure 2 for the following analysis. The input voltage to the modulator is obtained from the modulator high voltage power supply. As shown in the shaded area, L1 is in the charge path of the PFN. This is the charging inductor and its function in the circuit is to provide an inductive kick which <u>nearly doubles the charge of the PFN</u> as compared to the output voltage from the modulator high voltage power supply. Another very important function of L1 is it provides isolation of the PFN from the power supply.

The two functions performed by the charging inductor L1 are:

a. It nearly ____________ the ________ of the PFN.

b. It provides ________ of the _________ from the modulator power supply during the charging cycle.

---

a. doubles voltage.

b. isolation PFN.

42. Select the two functions performed by the charging inductor L1.

a. Generates the input pulse to the PFN.

b. Provides isolation of the PFN from the modulator power supply during the charging cycle of the PFN.

c. The charge of the PFN is nearly doubled due to the inductive kick of L1.

b,

c.

43. The high voltage for the PFN also passes through the holding diode CR1 before being applied to the pulse forming network. Since the input voltage has a positive polarity, the diode will be forward biased--thus passing the voltage. At the peak of the positive swing each "leg" of the PFN will have assumed a charge shown by the polarity markings on the inductors and capacitors at figure 9. The charge path of the PFN is from ground up through the pulse transformer T7, to each "leg" in the PFN, and through holding diode CR1 and the charging inductor.

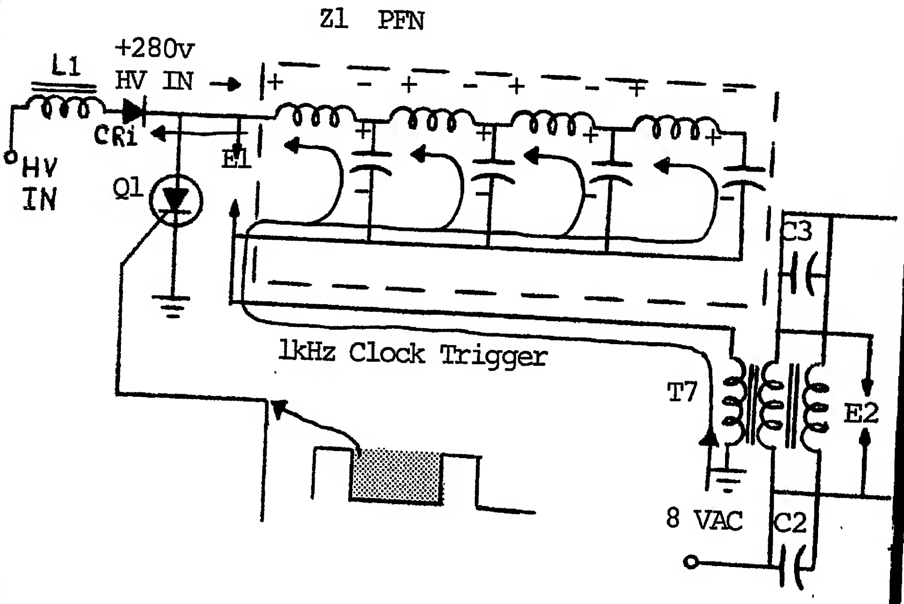


FIGURE 9: PULSE FORMING NETWORK CHARGING SEQUENCE

43. (Continued)

Only through these components will a path for charge current be established. The PFN will assume a charge of approximately 1.8 times the voltage from the modulator power supply. During this charge time, remember that the 1 kHz clock trigger is not coming in to gate the SCR into conduction. Also incorporated in the circuit is a spark gap, E1, which imposes the voltage upper limit during the charging cycle by arcing if the required voltage level is exceeded.

The charge path of the PFN includes T7 primary, _________ __________ and _________.

Z1,
CR1,
L1.

44. Select the four components included in the charge path of the PFN. (Refer to figure 2).

a. Q1.

b. Z1.

c. L1.

d. CR2.

e. CR1.

f. T7.

P.I.	
b, c, e, f.	45. Select two statements that describe the function of the charging inductor, L1. a. L1 provides an inductive kick which nearly doubles the charge of the PFN. b. Supplies 28 vdc to M4. c. Provides isolation of the modulator power supply by limiting the rate of current flow during the charge cycle. d. Limits the rate at which voltage is taken from the modulator power supply.
a, c	46. When the SCR (Q1) is triggered into conduction by the 1 kHz clock trigger, a discharge path for voltage stored in the PFN is formed. This discharge path is through the primary winding of T7, to ground, and up through the SCR to the opposite side of the PFN (shown at figure 10 by the shaded area).

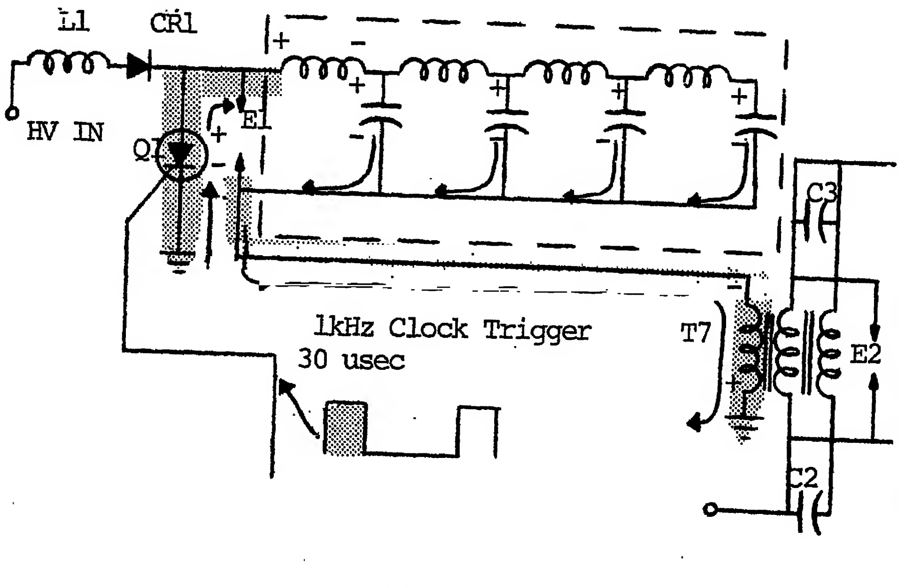


Figure 10: PULSE FORMING NETWORK DISCHARGE SEQUENCE

46. (Continued)

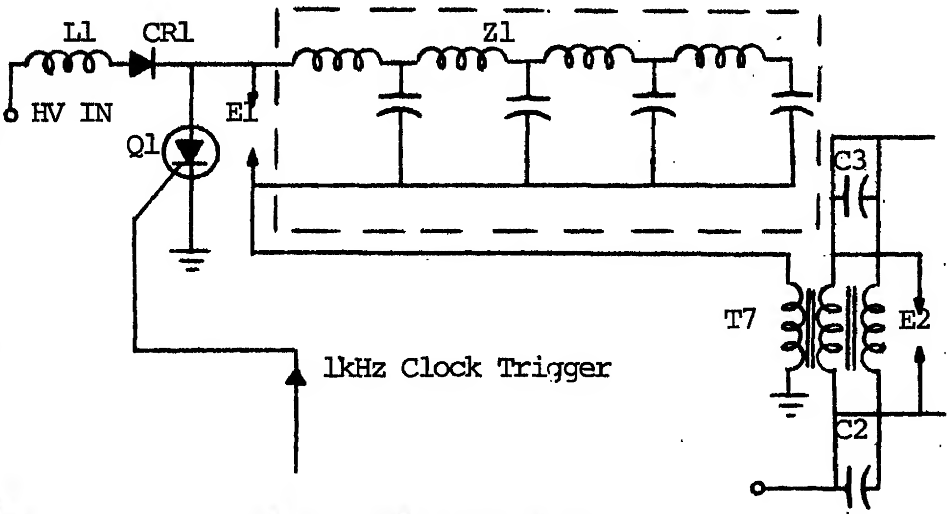
During the 1 kHZ clock trigger, the pulse forming network will completely discharge all previously stored voltage.

As the PFN discharges through the primary of T7, the voltage will be coupled across and fed to the magnetron.

The components included in the discharge path of the PFN are T7 primary, ________, and ________.

Z1
Q1

47. Select the components in the discharge path of the PFN.



PULSE FORMING NETWORK

see next page

47. (Continued)

a. secondary T7, Q1, Z1

b. primary T7 only

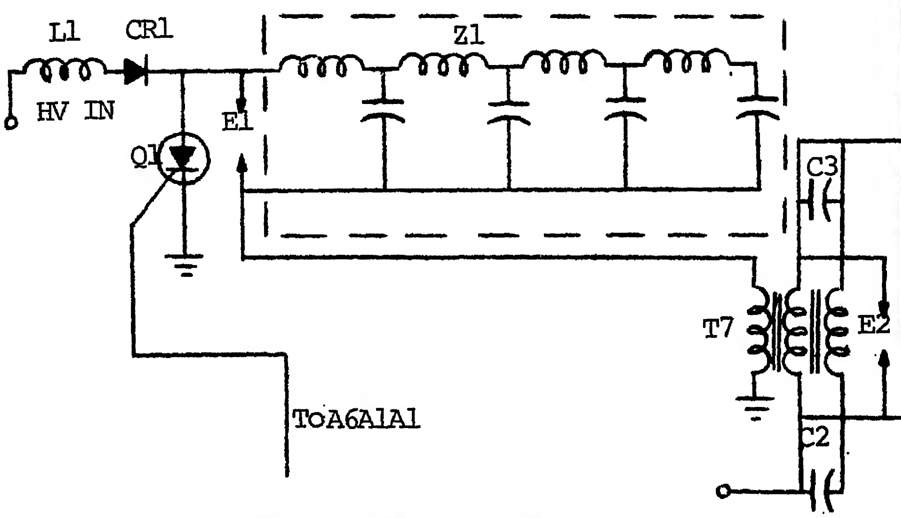
c. primary T7, Q1, Z3

d. primary T7, Q1, Z1

e. L1, CR1, Z1

d

48. Select the components that are included in the charge path of the pulse forming network below.



PULSE FORMING NETWORK

a. Q1 and E1

b. C3 and E2

c. T-7 secondary, C2

d. T-7 primary, Z1, CR1, L1

e. T-7 primary, secondary and C2

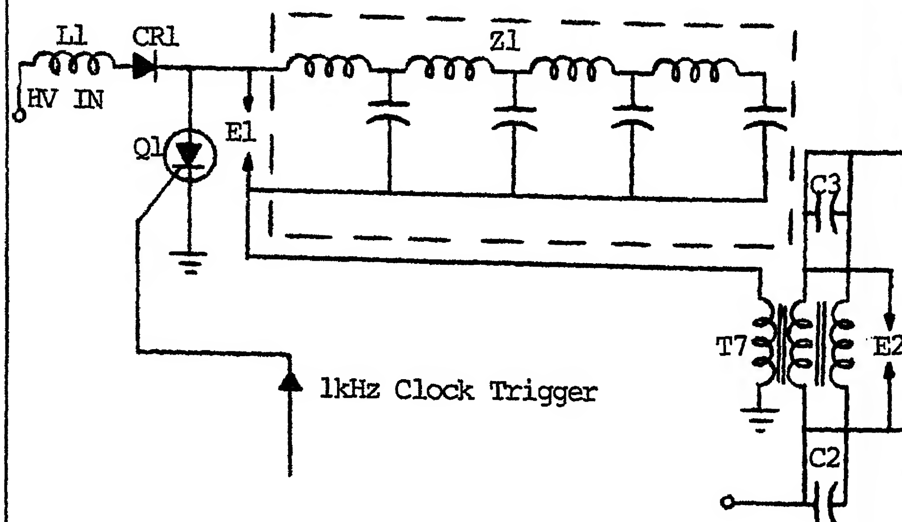
P.I.

P.I.	
d	49. The only component in the associated circuitry of the PFN that helps protect the other circuits from being damaged during the high voltage discharge of the PFN is the component CR1. This is referred to as the holding diode. The diode is connected in the circuit in such a manner so that it prevents the discharge of the PFN back through the modulator power supply. During troubleshooting of the modulator unit, if any excessive amount of voltage is being fed back into the modulator power supply, check the holding diode to see that it is operating properly. Holding diode ________ prevents the discharge of the PFN back through the ________ __________ ______.
CR1 modulator power supply	50. Holding diode CR1 prevents the discharge of the pulse forming network back through the modulator power supply. ____________________ TRUE/FALSE.

P.I.

TRUE.

51. Select the components that are included in the discharge path of the pulse forming network below.



a. T7 secondary, E2, E1

b. Q1, Z1 only

c. primary T7, Q1, Z1

d. primary T7, Q1, Z3

e. primary T7 only

c

52. Select the statement that describes the function of the holding diode CR1.

a. allows the PFN to discharge

b. prevents the discharge of the PFN back through the modulator power supply.

c. applies a pulse to the magnetron.

d. allows K3 to deenergize

P.I.

b

At this point, you may take the lesson topic progress check. You may find it beneficial to review the objectives for this lesson topic. If you answer all self-test items correctly, go on to the next lesson topic. If not, select and use another medium of instruction, narrative, or consultation with the learning supervisor, until you can answer all self-test items on the progress check correctly (achieve lesson topic learning objectives) and then proceed to the next lesson topic.

AVIONICS TECHNICIAN COURSE, CLASS A1

UNIT 5

MODULE 6

LESSON TOPIC 3

PULSE TRANSFORMER NETWORK

NOVEMBER 1975

OVERVIEW

LESSON TOPIC 5-6-3

PULSE TRANSFORMER NETWORK

In the preceeding lesson topic you studied the operation of the pulse forming network and the SCR control circuitry. You may recall that the PFN discharges the stored voltage through the primary winding of the pulse transformer T7.

In this lesson topic, the characteristics and operation of the pulse transformer will be explained. You will be introduced to new terms concerning the electrical characteristics of the transformer. A complete understanding of these terms will enable you to complete the self test at the completion of this program.

The learning objectives for this lesson topic are as follows:

1. Select from a list the two statements that correctly describe the functions of a pulsed transformer with bifilar windings.

2. Select from a list of schematic symbols the symbols that represent a pulse transformer with bifilar secondary windings.

3. Select from a list of schematic symbols, the symbols that represent a spark gap.

4. Select from a list the statements that correctly describe the electrical functions of a spark gap, and its principle of operation.

5. Refer to the modulator power supply schematic diagram, figure 5-19. Select the statements that describe the connections of the pulse transformer in the circuit.

NOTE: All objectives in this lesson topic must be accomplished with 100 percent accuracy, unless otherwise stated.

Prior to beginning this lesson topic, carefully review the "List of Study Resources". Keep in mind that your learning supervisor can be your most valuable learning resource. Always feel free to consult with him if you have problems or questions.

LIST OF STUDY RESOURCES

LESSON TOPIC 5-6-3

PULSE TRANSFORMER NETWORK

To learn the material in this lesson topic, you may choose, according to your experience and preferences, any or all of the following written lesson topic presentations.

WRITTEN LESSON TOPIC PRESENTATIONS IN MODULE BOOKLET:

1. Lesson topic summary.
2. Programmed instruction form of lesson topic.
3. Narrative form of lesson.
4. Lesson topic progress check.

ADDITIONAL MATERIALS REQUIRED FOR SUCCESSFUL COMPLETION OF LESSON TOPIC:

1. Job Program in Job Program Booklet.
2. Student response sheets.
    a. Answer sheet for use with test.
    b. Programmed instructions response sheets.

ENRICHMENT MATERIALS (topic references):

1. 15A21 MIM.
2. Basic Electronics, Volume II.

All the resources listed above are available and may be used as you see fit. Your learning supervisor represents a most valuable learning resource. Use him when you need help. It is not necessary to use all the resources to achieve the learning objectives for the lesson topic. The lesson topic progress check is your means of determining when you have achieved the objectives. The progress check may be taken at any time and is graded by you. If you fail to achieve any objective at the lesson topic level, you will plan and accomplish your own remediation. If you need help in remediation planning, consult your learning supervisor.

P.I.

PROGRAMMED INSTRUCTION

PULSE TRANSFORMER NETWORK

1. Refer to figure 5-19 (sheet 2 of 2) in the MIM. The pulse transformer in the modulator is shown on the schematic of the Modulator Power Supply Group, figure 5-19, sheet 2 of 2. The pulse transformer is reference designated as A6A1T7 and it acts as a load during the discharge cycle of the pulse forming network. The voltage discharged by the PFN is coupled across the primary and secondary windings of T7 and applied to the magnetron. The functions of the pulse transformer are to step-up the voltage output of the PFN to a level sufficient to operate the magnetron and to isolate the modulator's pulse from the filament source voltage. The filament source in this case is 8 vac, as shown on the schematic.

The function of the pulse transformer is to step up the ______________ voltage of the PFN to a level sufficient to operate the magnetron and to isolate the modulators pulse from the filament ______________.

F.I.	
output source voltage	2. The pulse transformer steps up the output voltage of the PFN to a level sufficient to operate the magnetron and isolates the modulators pulse from the filament source voltage. (TRUE/FALSE)
True	3. The design of the pulse transformer is critical because of the high frequency components present in the output pulse. The core is usually composed of thin laminations of ferro-magnetic material, usually silicon steel. Close coupling between the primary and secondary windings reduces inductive losses to preserve the steep leading edge of the input pulse. Low interwinding capacitance is desired to prevent high frequency oscillations. Close coupling is attained between primary and secondary windings by winding the primary directly on the secondary and by using the same leg of the core for both windings. The secondary windings of the pulse transformer are BIFILAR; that is, they are made by

3. (Continued)

winding two insulated conductors side by side so the same amount and polarity of voltage is induced in each winding. The schematic symbols for the pulse transformer with bifilar secondary windings used in pulse modulators are shown in figure 1. (Refer also to the Modulator Power Supply Group schematic diagram, figure 5-19, sheet 2 of 2). Figure 1A is the type used in the airborne search radar trainer.

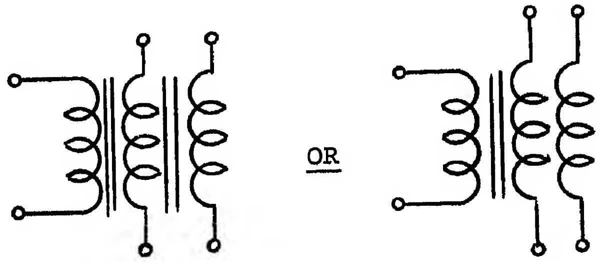


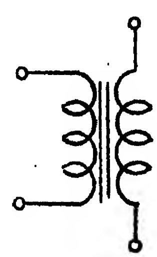
Figure 1

BIFILAR TRANSFORMER: SCHEMATIC SYMBOL

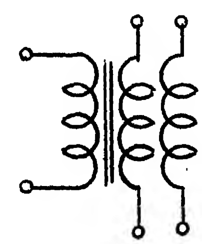
The 8 vac filament voltage is applied through the bifilar secondary of the pulse transformer to the magnetron heater. If a single secondary pulse transformer were used, a filament transformer with high voltage insulation between windings would be

P.I.	
	3. (Continued) required. Capacitors C2 and C3 prevent oscillations in the bifilar windings during the development of the high voltage pulse. The bifilar transformer has ______________ secondary winding(s).
two	4. Select two correct schematic symbols for a pulse transformer with bifilar secondary windings.

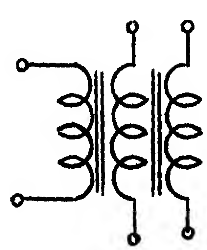
a.



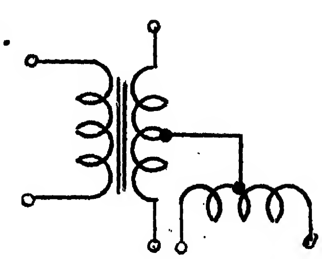
b.



c.



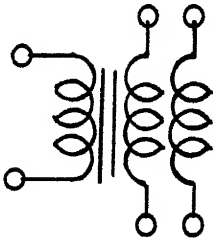
d.



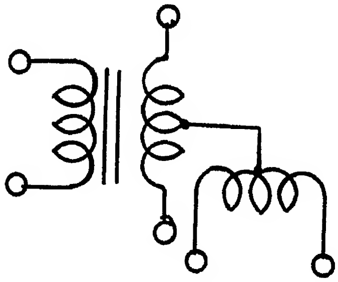
P.I.	Module 5-6 Lesson Topic 5-6-3
b, c.	5. The function of a pulsed transformer with bifilar windings is to isolate the modulator pulse from the filament source voltage and to a. step down the output of the PFN voltage in order to increase current level for proper magnetron operation. b. isolate the magnetron current meter from the STC circuit. c. step up the filament voltage to the magnetron. d. step up the output voltage of the PFN to a sufficient level to operate the magnetron.
d.	6. Which two statements describe the functions of a pulsed transformer with bifilar windings? a. Isolates the modulator pulse from the filament source voltage. b. Steps up the filament voltage to the magnetron. c. Steps up the output of the PFN to a level sufficient to operate the magnetron. d. Isolate the magnetron meter network from filament voltages.

7. The two schematic symbols for a pulse transformer with bifilar secondary windings are

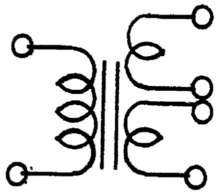
a.



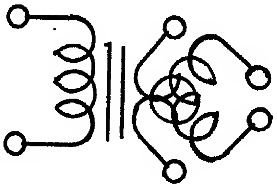
b.



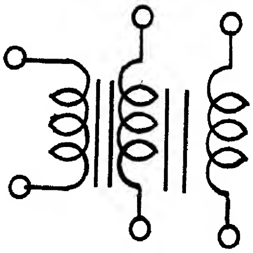
c.



d.



e.



P.I.

a, e.

From the information already presented on the pulse forming network and the pulse transformer, an analysis of the overall function of the circuits may be made. Refer to figure 2.

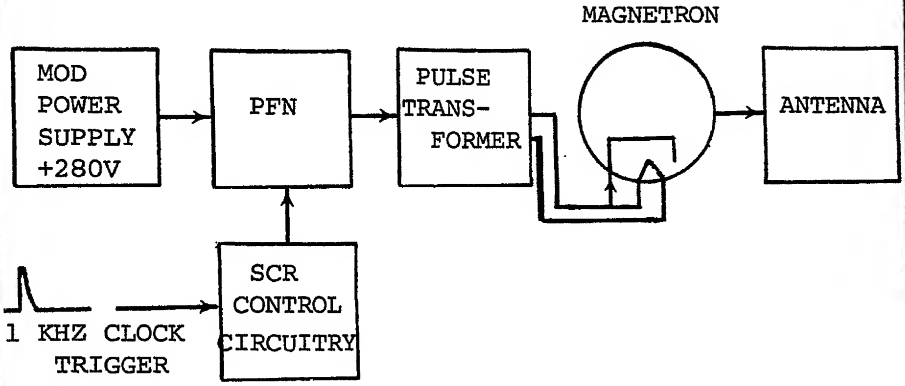


FIGURE 2
MODULATOR AND TRANSMITTER BLOCK DIAGRAM

Remember that the PFN will assume a charge of voltage approximately 1.8 times that of the input voltage from the power supply. When the 1 kHz clock trigger arrives at the SCR, the SCR becomes forward biased, thus providing a discharge path for the PFN. The PFN then discharges through the pulse transformer where the voltage is stepped up approximately 8 times. This negative pulse is applied to the cathode of the magnetron. The

P.I.

(Continued)

magnetron will then produce the rf energy which is coupled to the antenna to be radiated.

NO RESPONSE REQUIRED

8. Occasionally, an overvoltage condition may exist in the PFN or pulse transformer. The line may charge to a higher voltage than normal, and an excessively high negative pulse will be applied to the magnetron. Spark gap devices are used in the modulators of pulsed radar systems to prevent development of excessive voltages which can damage the PFN, pulse transformer and the magnetron. The two schematic symbols shown in figure 3 represent a spark gap device. (The symbol may be drawn either way shown.)

8. (Continued)

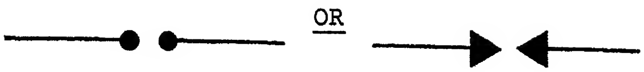


Figure 3

The two symbols shown in figure 3 represent a ____________________

__________________ __________________.

---

spark gap device

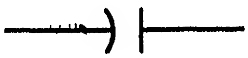
9. Select the two symbols for the spark gap device.

a. 

b. 

c. 

d. 

e. 

P.I.

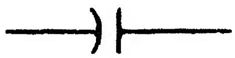
c, d.	10. The function of a spark gap device is to protect the pulse forming network, pulse transformer, and the magnetron from excessive current by limiting the maximum voltage applied to each device. The spark gap, as the name implies, will arc when the voltage across it's electrodes reaches a specific level. In some radars, the limited voltage level can be controlled by adjusting the electrodes which changes the gap width. The voltage is limited when the arc occurs because of the loading effect of the arc. Spark gap devices are used to protect components in a radar modulator/transmitter from excessive ____________ by ____________ the maximum voltage.
current limiting	11. The function of the spark gap device is to protect the circuit components in the modulator/transmitter from excessive __________ by limiting the lse width __________ voltage. aimum

current

maximum

12. The two symbols for a spark gap device are:

a. 

b. 

c. 

d. 

e. 

d,

e.

13. For the following explanation, refer to figure 5-19, sheet 2 of 2. The primary of the pulse transformer, T7, is connected in series with the pulse forming network. Pin 1 of T7 is connected to the cathode of the SCR, Q1. The anode of Q1 is connected to the positive side of the pulse forming network, Z1. Pin 2 of the pulse transformer is connected to the negative side of the PFN. The spark gap E1 is connected in parallel with the PFN and in series with the pulse transformer. The spark gap will arc if the voltage across the electrodes reaches a specific level.

The cathode of the SCR (Q1) is connected to the primary of the pulse transformer. TRUE/FALSE.

TRUE	14. The primary of the pulse transformer is connected to (choose one from each group): Q1/Q1A, Z1/XA1, E2/E1.
Q1, Z1, E1.	15. Select the statement that describes the function of a spark gap and its principles of operation. a. It establishes the minimum circuit voltage by limiting the minimum voltage. b. It controls circuit oscillations to provide impedance matching. c. Protects the circuit components in the modulator/transmitter from excessive currents by limiting the maximum voltage. d. It controls circuit oscillations while limiting the minimum voltage.
c.	16. Refer to figure 5-19, sheet 2 of 2, in the MIM, and notice that the secondary (bifilar) windings of the pulse transformer are connected to the spark gap E2, C2, C3, connector J-7 (to the magnetron), relay K4, and the 8 vac input to the magnetron filament.

16. (Continued)

The 8 vac is applied to the filament of the magnetron via the bifilar windings of the pulse transformer, T7 (pins 3 to 4 and 5 to 6) and the output jack J7. The negative high voltage pulse is taken from pin 4 of the bifilar windings and is applied to the cathode of the magnetron via the center conductor of the coaxial cable, connected between the output connector J7 and the magnetron.

Capacitors C2 and C3 are connected in parallel with the bifilar windings to prevent them from oscillating during the application of the high voltage pulse. A sample of the high voltage pulse is taken from pin 3 of T7 and is applied to the magnetron metering circuit via relay K4, pins 4, 6, 2 and 8. Meter M4 will indicate magnetron current only during the time the transmitter is ON.

When the meter select switch is switched to MAG I position, relay K4 will energize placing M1 and M4 in series, therefore both meters will indicate MAG I.

The components connected to the secondary winding of the pulse transformer are E2, C2, C____, connector J7, relay K____, and the 8 vac input.

P.I.	
3, 4.	17. The secondary windings of the pulse transformer are connected to E2, C2, C3, J7, K4 and the 8 vac input to the magnetron filament. TRUE/FALSE.
TRUE	18. The primary of the pulse transformer is connected to which components? a. Z1, CR1. b. Z1, Q1. c. E1, Q1, Z1. d. 8 vac, K4.
c.	19. The secondary (bifilar) windings of the pulse transformer are connected to: (Select three). a. C2, C3, K4. b. C2, C1, M6. c. A1, Z1. d. E2, J7. e. M4, 8vac filament source.

P.I.

Module 5-6
Lesson Topic 5-6-3

a,
d,
e.

At this point, you may take the lesson topic progress check. You may find it beneficial to review the objectives for this lesson topic. If you answer all self-test items correctly, go on to the next lesson topic. If not, select and use another medium of instruction, narrative, or consultation with the learning supervisor, until you can answer all self-test items on the progress check correctly (achieve lesson topic learning objectives) and then proceed to the next lesson topic.

AVIONICS TECHNICIAN COURSE, CLASS A1

UNIT 5

MODULE 6

LESSON TOPIC 4

MAGNETRON AND MAGNETRON CIRCUITS

NOVEMBER 1975

OVERVIEW

LESSON TOPIC 5-6-4

MAGNETRON AND MAGNETRON CIRCUITS

This lesson topic is concerned with the magnetron and its' theory of operation in an airborne search radar system. A complete and thorough understanding of the magnetron and its associated circuitry will further improve your knowledge of the airborne search radar system transmitter.

The learning objectives for this lesson topic are as follows:

1. Select from a list the definition of a magnetron.

2. Given a list of schematic symbols, select the one that identifies a magnetron.

3. Select from a list the statement that describes the function of a magnetron.

4. Select from a list of schematic symbols the symbol for a tuneable magnetron.

5. Select from a list the pulse required to initiate operation of the magnetron.

6. Select from a list the component within the receiver-transmitter that is connected to the input of the magnetron.

NOTE: All objectives in this lesson topic must be accomplished with 100 percent accuracy, unless otherwise stated.

Prior to beginning this lesson topic, carefully review the "List of Study Resources." Keep in mind that your learning supervisor can be your most valuable learning resource. Always feel free to consult with him if you have problems or questions.

LIST OF STUDY RESOURCES

LESSON TOPIC 5-6-4

MAGNETRON AND MAGNETRON CIRCUITS

To learn the material in this lesson topic, you may choose, according to your experience and preferences, any or all of the following written lesson topic presentations.

WRITTEN LESSON TOPIC PRESENTATIONS IN MODULE BOOKLET:

1. Lesson topic summary.
2. Programmed instruction form of lesson topic.
3. Narrative form of lesson topic.
4. Lesson topic progress check.

ADDITIONAL MATERIALS REQUIRED FOR SUCCESSFUL COMPLETION OF LESSON TOPIC:

1. MIM, Airborne Search Radar System Trainer, 15A21.
2. Airborne Search Radar System Trainer, 15A21.
3. Oscilloscope, USM-281D.
4. Echo Box, TS-488A.

ENRICHMENT MATERIALS:

Aviation Fire Control Technician 1 & C, NAVPERS 10390, Chapter 6.

All the resources listed above are available and may be used as you see fit. Your learning supervisor represents a most valuable learning resource. Use him when you need help. It is not necessary to use all the resources to achieve the learning objectives for the lesson topic. The lesson topic progress check is your means of determining when you have achieved the objectives. The progress check may be taken at any time and is graded by you. If you fail to achieve any objective at the lesson topic level, you will plan and accomplish your own remediation. If you need help in remediation planning, consult your learning supervisor.

PROGRAMMED INSTRUCTION

MAGNETRON AND MAGNETRON CIRCUITS

INTRODUCTION

A magnetron is used as a transmitting tube in almost all pulsed radar transmitters that operate at frequencies above 1000 MHz. They are capable of being operated at more than 50 percent efficiency and can produce pulse power outputs at frequencies as high as 100,000 MHz. The peak power output of a magnetron may vary from a few kilowatts to several megawatts.

The magnetron, which is a self-excited oscillator, possesses rather poor frequency stability as compared with the more stable lower frequency oscillators (electron coupled or crystal-controlled). However, by use with automatic frequency control (AFC) circuits, the magnetron performs well as a radar transmitter.

This lesson will afford you the opportunity to learn the symbols for and the characteristics of two basic types of magnetrons - those that are tuneable and those that are non-tuneable.

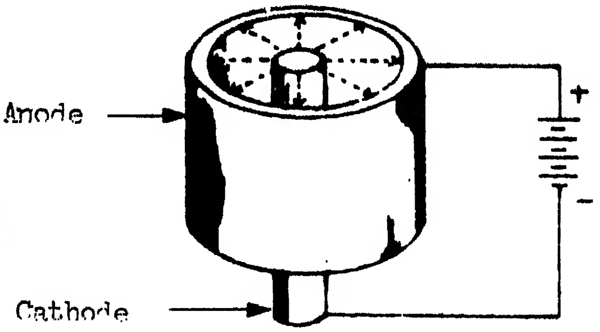
P.I.	Module 5-6 Lesson Topic 5-6-4
	1. The magnetron is an oscillator unlike any other that has been previously discussed in this unit. The magnetron is a selfcontained unit, that produces microwave energy with a high peak power output. Magnetrons are referred to as microwave power oscillators. A magnetron is a special vacuum tube diode having a magnetic field in the space between its anode and cathode. The magnetic field controls the electron path of the electrons as they flow from the cathode toward the anode. Refer to figure 1. Notice that the anode (plate) of the magnetron does not have the same physical appearance as the plate of an ordinary vacuum tube. Since conventional LC networks become impractical for use at high frequencies, the anode of the magnetron is fabricated into a cylindrical block containing <u>High Q resonant cavities</u> which serve as tuned circuits. The cathode and filament are at the center of the tube. The high negative pulse from the

P.I.

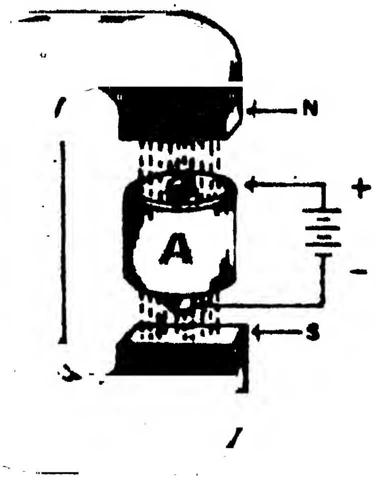
1. (continued)

pulse transformer is connected to the cathode to initiate operation of the magnetron oscillator.

The magnetron is a microwave ______________ oscillator.



Diode



Magnetron

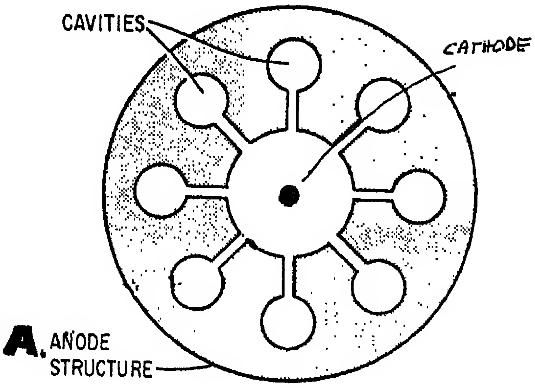
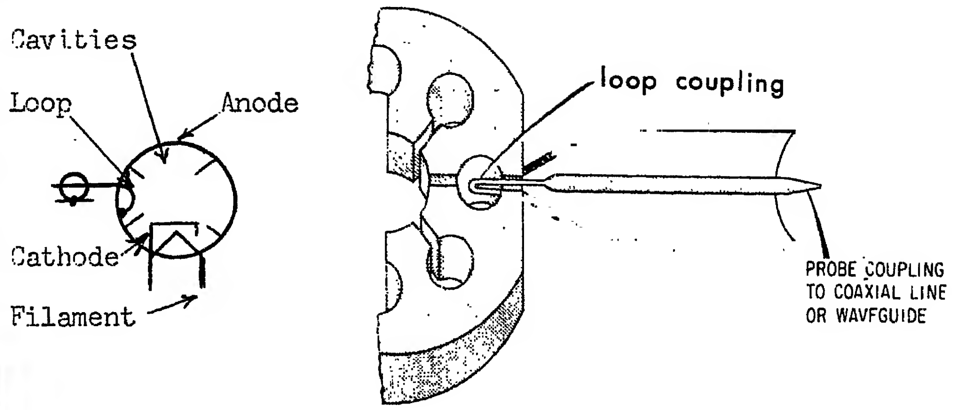


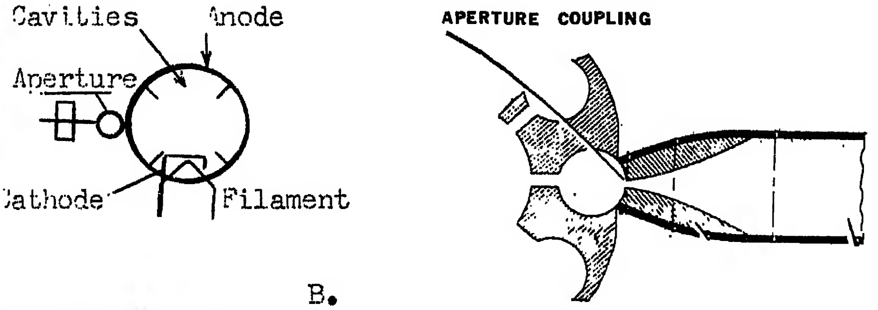
FIGURE 1
THE BASIC MAGNETRON

P. I.	
power	2. The microwave power oscillator is an airborne search radar system is referred to as a magnetron. (TRUE/FALSE)
True	3. Magnetrons in use today are fixed tuned oscillating devices. Figure 2 shows two schematic symbols that represent magnetrons that are fixed tuned. The symbol and illustration shown in figure 2A represents a magnetron that uses a loop to couple the rf from the cavity and a probe to couple the rf into a waveguide or a coaxial line. The symbol shown in figure 2B depicts a magnetron that utilizes aperture coupling from the magnetron cavity into a waveguide. The basic symbol is the same for all magnetrons with exception of the symbol that represents the type of output coupling used.

3. (Continued)



A. **RESONANT TYPE WITH COAXIAL OUTPUT**

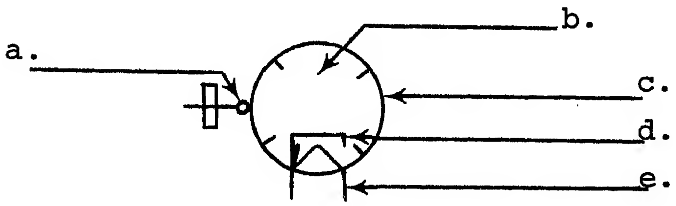


B.

Figure 2

Magnetron Symbols

Label the elements shown in the schematic symbol of a magnetron.



a. aperture coupling.

b. cavities.

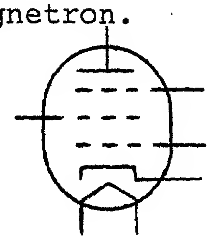
c. anode.

d. cathode.

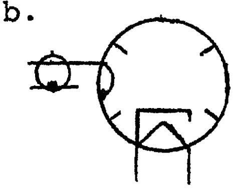
e. filament.

4. Select the correct schematic symbol for a magnetron.

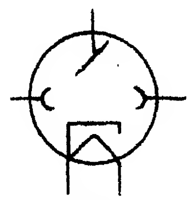
a.



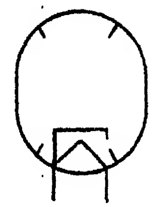
b.



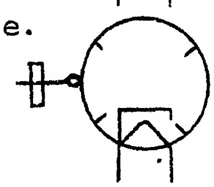
c.



d.



e.



b,e

5. A magnetron is a microwave power ________

a. inductor.

b. tank circuit.

c. oscillator.

d. beam power tube.

e. thyristor.

c. A cutaway view of a non-tuneable magnetron is is shown at figure 3. The cathode and filament are at the center of the tube. The output lead is usually a probe or loop extending into one of the tuned cavities and coupled into a wave-guide or coaxial line. The high negative voltage pulse from the modulator is coupled to the cathode, and the anode is at ground potential.

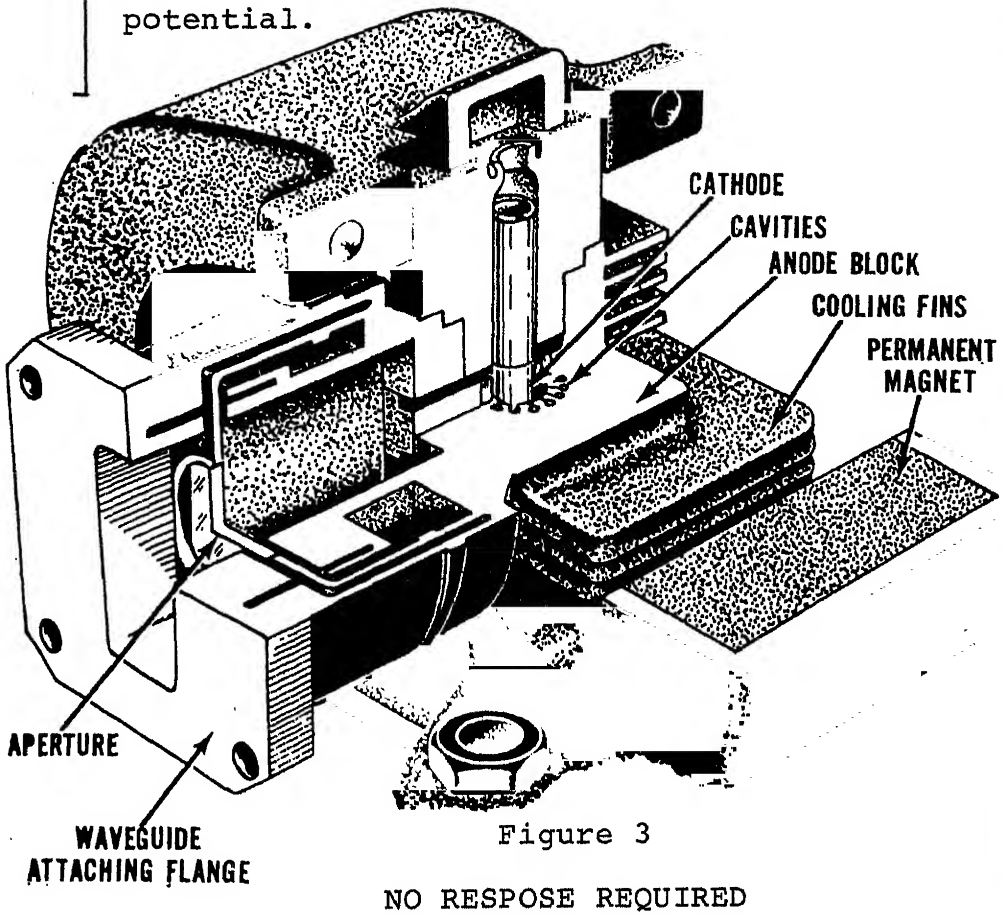


Figure 3

NO RESPOSE REQUIRED

6. As previously stated, the magnetron is a microwave power oscillator, which may be capable of producing a large peak power output. This power output is referred to as radio-frequency (rf) power, and is produced in the microwave frequency spectrum, ranging from 1,000 megahertz to about 100,000 megahertz. This high power output in the microwave frequency spectrum, makes the magnetron a very useful oscillator for use in radar systems.

The function of a magnetron is to produce a high power output in the __________ frequency spectrum.

microwave

7. The function of the magnetron is to produce a high power output in the ________________ frequency spectrum.
microwave/pulsed

microwave

8. A magnetron is
   a. a triode.
   b. a microwave power oscillator.
   c. an oscillator of only one type of construction.
   d. a device that cannot be set for a specific frequency.
   e. a device that contains tank circuits.

P.I.

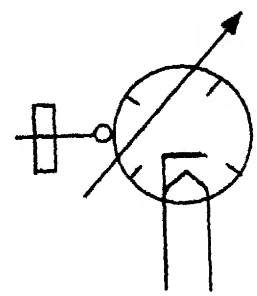
b.

9. Now that you have studied the function of a magnetron and the schematic symbol for the non-tunable magnetron, lets move on and cover the schematic symbol for a tuneable magnetron. Refer to figure 4A. (Figure 4B shows the type of tuneable magnetron used in the airborne search radar trainer.)

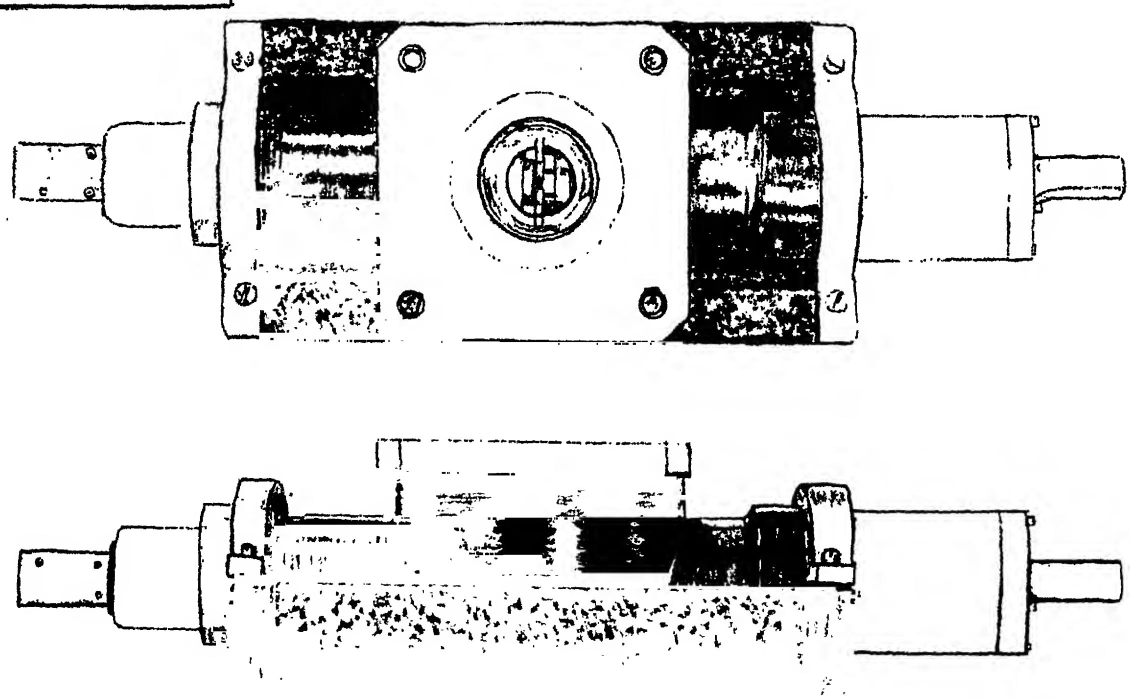
Tuneable magnetrons can be tuned over a range of frequencies by mechanical means. The capacitance or inductance of the resonant cavity is varied mechanically to achieve tuning. The arrow going through the schematic symbol of the magnetron shows that the magnetron is tuneable.

The schematic symbol for a tuneable magnetron is the same as that for a non-tuneable magnetron. (TRUE/FALSE).

9. (Continued)

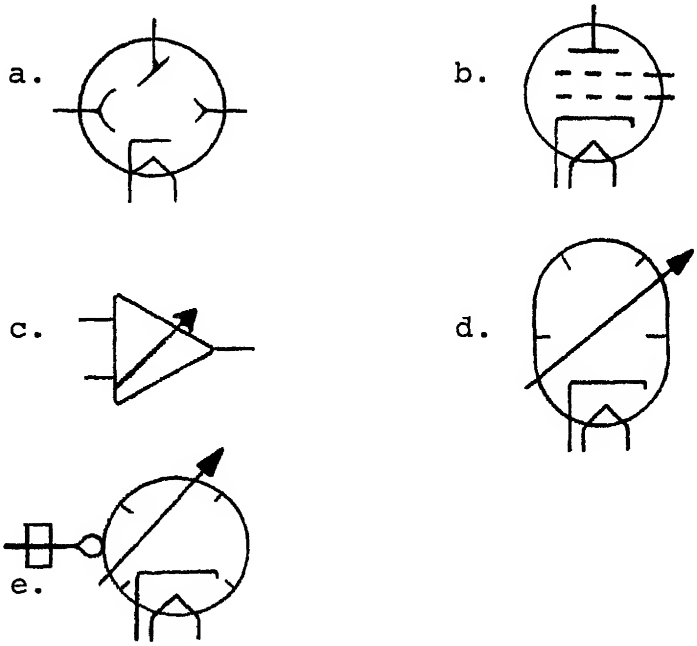
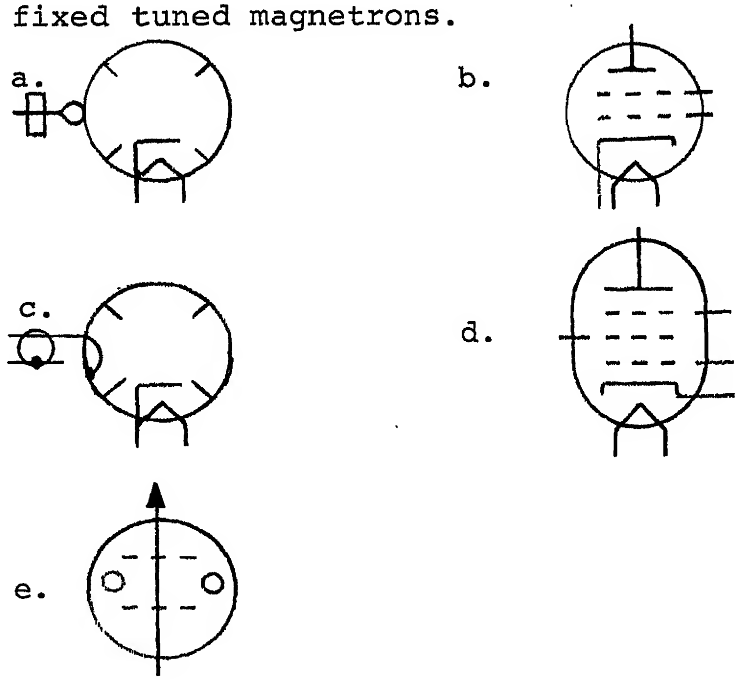


A



B

FIGURE 4
Schematic Symbol for a Tuneable Magnetron (A)
Tuneable Magnetron Used in the Airborne Search Radar System Trainer (B)

P.I.	
false	10. The schematic symbol for a tuneable magnetron is 
e.	11. Select two schematic symbols that represent fixed tuned magnetrons. 

P.I.

a,c

Magnetrons are very difficult to tune, since the resonant cavities are generally enclosed in a vacuum and are inaccessible. Therefore precise mechanical tuning is slow and difficult. Mechanical tuning is done by movement of a mechanical or magnetic device. Ranges of about plus or minus 10 percent of the desired frequency can be obtained by mechanical tuning methods, two of which are shown in figure 5. In (A), moveable tuning plugs are inserted in each of the cavities in order to vary the cavity inductance. In (B), tuning is accomplished by varying the capacitance of the cavity. This is accomplished by moving a U-shaped ring in or out of grooves cut into the anode block. When the ring moves into the grooves the frequency of the magnetron is increased.

<u>NO RESPONSE REQUIRED</u>

12. The function of a magnetron is to

a. aid in charging the pulse transformer network.

b. provide +280vdc for the pulse forming network.

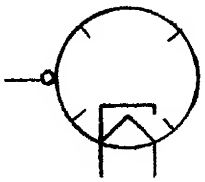
c. serve as a low Q oscillator.

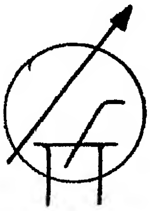
d. produce a microwave frequency.

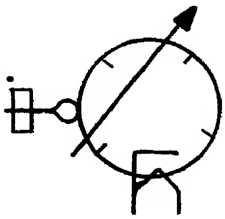
e. provide coupling between two i-f stages.

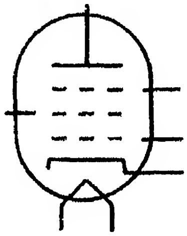
d.

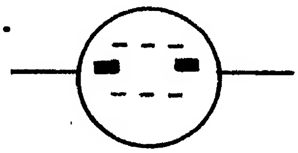
13. Select the schematic symbol for a tuneable magnetron.

a.


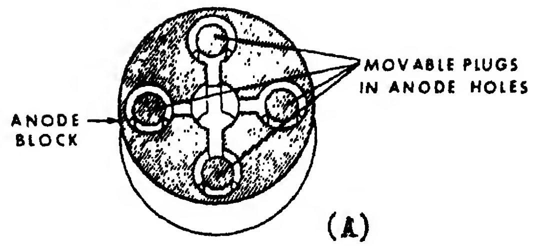
b.


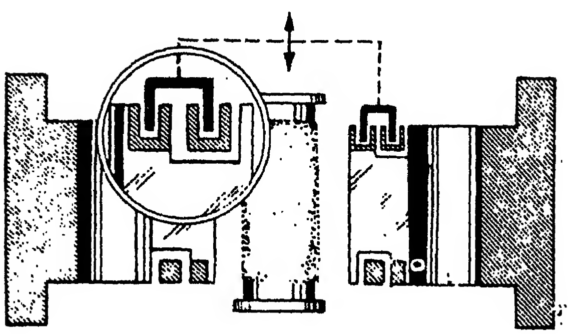
c.


d.


e.


c.





(B)

FIGURE 5

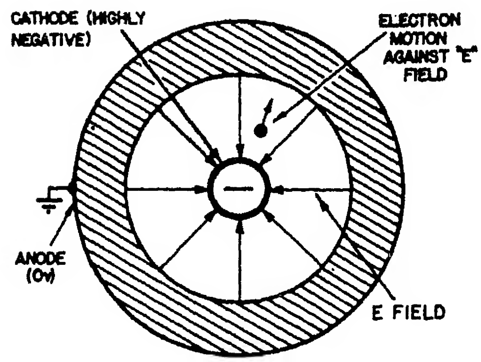
METHODS OF MAGNETRON TUNING

NOTE: Although you will not be tested on the following information it will be presented in order for you to gain an insight into the electrical operation of the magnetron.

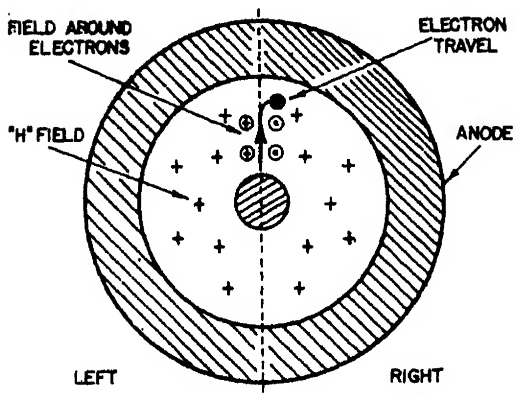
The theory of operation of the magnetron is based on the motion of electrons under the influence of combined electric and magnetic fields. The dc electric field exerts a force from the anode to the cathode in the magnetron. The law governing the motion of an electron in the dc electric or E field states; the force exerted by an electric field on an electron is proportional to the strength of the field. The electrons leaving the cathode will move in a direct path to the anode, under the influence of the dc electric field as shown in figure 6a.

The addition of a dc magnetic field will alter the path the electron travels. The law of motion of an electron in a magnetic or H field, states that the force exerted on an electron is at right angles to both the field and the path of the electron. The direction of the force is such that the electron paths are clockwise when viewed in the direction of the magnetic.

field as shown in figure 6b.



A. Electron motion in an Electric Field.



NOTE: The d-c magnetic field is from North Pole to South Pole going into the page.

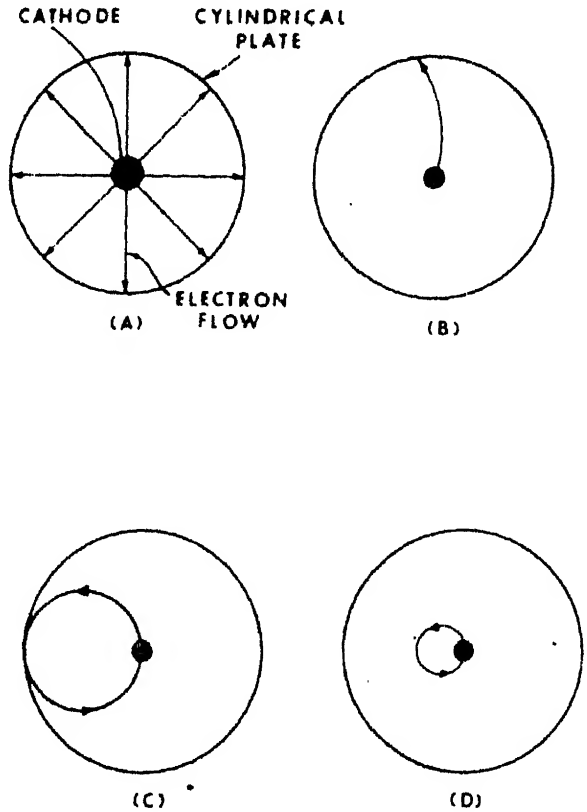
B. Electron Motion in a Magnetic Field.

Figure 6

If the dc magnetic field strength is ~~increased~~, the electron path will bend more sharply. Likewise, if the velocity of the electron decreases, the field around it increases and its path will bend more sharply.

Figure 7a shows Electron flow with the dc electric field but without the dc magnetic field. When a magnetic field is placed around the magnetron, the electron assumes a curved path as shown in 7b. Increasing the magnetic field strength to a value great enough to cause the electron to just miss the anode and return to the cathode in a circular orbit as shown in figure 7c is referred to as the critical value of field strength. When the field strength has been increased to a point beyond the critical value, the electron is made to travel back to the cathode in a circular path of smaller diameter as shown in figure 7d.

The cavities within the anode block are made to oscillate by energy "given up" to the cavities rf field as the electrons graze the anode. This is shown in figure 8



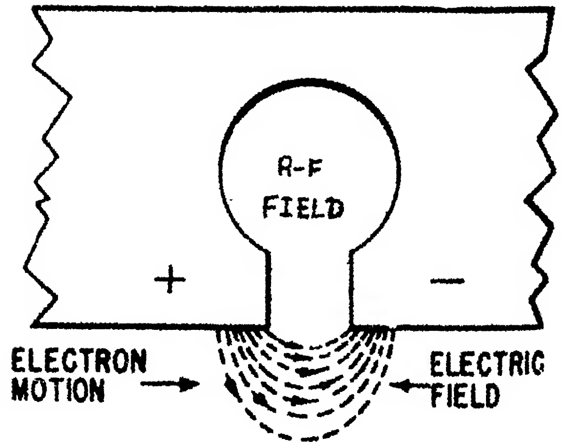
END VIEW OF MAGNETRON

Effect of Magnetic Field on Electron

Figure 7

The manufacturer establishes the magnetron operation in the area between figures 7c and 7d. A permanent magnet of sufficient strength and a particular cathode operating potential will ensure the operation in the areas mentioned.

The frequency of oscillations from a magnetron are determined by the physical size of the resonant cavities. Most magnetrons utilize a multiple-cavity anode block as shown in figure 9. Each cavity functions the same as the next one, all working together to provide a high rf energy output to the load. Figure 9 also shows the electron distribution between the cavities. The energy contained in the rf electric field within the cavities must be coupled to a load, such as an antenna or dummy load. This is made possible by inserting a coupling device, such as a loop or aperature in the cavity.



An electron approaching the slot of a cavity at a time when it will give up energy to the cavity's rf field.

Figure 8

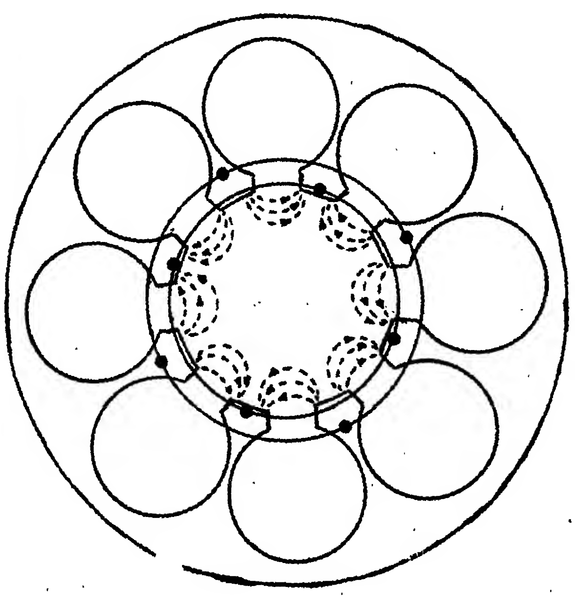


Figure 9

NO RESPONSE REQUIRED

14. At this time, let's briefly cover the circuits associated with the magnetron and review its overall operation. (Refer to figure 5-22.) The high amplitude negative voltage pulse output from the pulse forming network is coupled to the pulse transformer. The pulse is stepped up in value in the output windings of the pulse transformer and is referred to as the modulator pulse. The modulator pulse is coupled to the cathode of the magnetron which initiates the microwave oscillations. The microwave energy is coupled from the magnetron to the antenna through waveguide sections.

The microwave oscillations in the magnetron are initiated by the _______________ _____________.

modulator pulse.

15. The modulator pulse is applied to the magnetron to initiate microwave oscillations. TRUE/FALSE.

P.I.	
TRUE	16. As previously stated, the <u>secondaries</u> of the <u>pulse transformer</u> are connected to the cathode of the magnetron. Refer to J7 of Figure 5-19 (sheet 2 of 2) and J1 of figure 5-22 (sheet 1 of 2) in the MIM. The high amplitude modulator pulse applied at J1 is applied to the cathode of the magnetron. The magnetron will develop the microwave oscillations only during the application of the modulator pulse. The output of the __________ transformer is coupled to the __________ of the magne-tron.
pulse cathode	17. The output of the pulse transformer is coupled to the cathode of the magnetron. TRUE/FALSE.
TRUE	18. The pulse applied to the magnetron to initiate microwave oscillations is the a. blanking pulse. b. low voltage pulse. c. STC trigger. d. modulator pulse. e. synchronizer pulse.

P.I.	
d.	19. Refer to the schematic of the modulator power supply group. The modulator pulse to the cathode of the magnetron is directly coupled from: a. the pulse transformer primary. b. the pulse transformer secondary. c. the pulse forming network. d. the inverse current sensing network.
b.	At this point, you may take the lesson topic progress check. You may find it beneficial to review the objectives for this lesson topic. If you answer all self-test items correctly, go on to the next lesson topic. If not, select and use another medium of instruction, narrative, or consultation with the learning supervisor, until you can answer all self-test items on the progress check correctly (achieve lesson topic learning objectives) and then proceed to the next lesson topic.

AVIONICS TECHNICIAN COURSE, CLASS A1

UNIT 5

MODULE 6

LESSON TOPIC 5

ISOLATING MALFUNCTIONING PARTS WITHIN THE MODULATOR AND TRANSMITTER SECTIONS OF A SEARCH RADAR

NOVEMBER 1975

OVERVIEW

LESSON TOPIC 5-6-5

ISOLATING MALFUNCTIONING PARTS WITHIN THE MODULATOR AND TRANSMITTER SECTIONS OF A SEARCH RADAR

In this lesson topic, you will be required to troubleshoot the Modulator and Transmitter Units of the airborne search radar system trainer to a defective component. This lesson topic will be accomplished entirely in the laboratory, utilizing the Job Program in the Job Program Booklet.

The learning objectives for this lesson topic are as follows:

Given the radar MIM and required test equipment, troubleshoot the radar modulator and transmitter sections to a defective stage, and then, troubleshoot the malfunctioning stage to a faulty component.

NOTE: The objective in this lesson topic must be accomplished with 90 percent accuracy.

Prior to beginning this lesson topic, carefully review the "List of Study Resources". Keep in mind that your learning supervisor can be your most valuable learning resource. Always feel free to consult with him if you have problems or questions.

LIST OF STUDY RESOURCES

LESSON TOPIC 5-6-5

ISOLATING MALFUNCTIONING PARTS WITHIN THE MODULATOR TRANSMITTER SECTIONS OF A SEARCH RADAR

There are no written lesson topic presentations for this lesson topic. You may review any resources in Module 5-6 before going to lab if you desire.

MATERIALS REQUIRED FOR SUCCESSFUL COMPLETION OF LESSON TOPIC:

1. Job program in Job Program Booklet.
2. Student response sheets.
3. Radar Troubleshooting Worksheet.

ENRICHMENT MATERIALS:

1. MIM, Airborne Search Radar System Trainer, 15A21.
2. Aviation Electronics Technician 3 & 2, NAVPERS 10317-E, Chapter 13, page 405.

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